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Borke

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(54) **DISPENSER HAVING MORE THAN ONE OUTPUT DRIVE CONDITION**

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A47K 10/36 (2006.01)
H02P 7/14 (2006.01)
A47K 10/34 (2006.01)
H02P 7/00 (2006.01)

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CPC ***A47K 10/3687*** (2013.01); ***H02P 7/14*** (2013.01); *A47K 10/34* (2013.01); *H02P 2007/0033* (2013.01)

(58) **Field of Classification Search**
CPC A47K 10/34
USPC 700/240
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,069,354 A * 5/2000 Alfano et al. 250/221
6,736,348 B1 5/2004 Formon et al.
6,903,654 B2 * 6/2005 Hansen et al. 340/562

(Continued)

FOREIGN PATENT DOCUMENTS

WO 2011059423 A1 5/2011

OTHER PUBLICATIONS

Written Opinion for International Application No. PCT/US2013/073784; International Filing Date Dec. 9, 2013; Date of Mailing: Mar. 4, 2014; 6 pages.

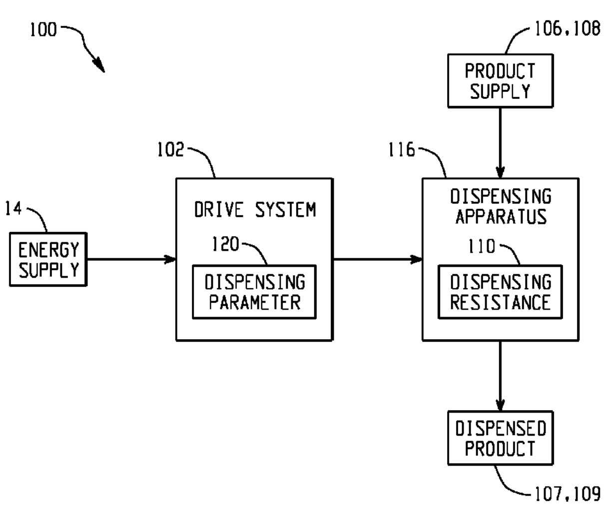
(Continued)

Primary Examiner — Michael K Collins
(74) *Attorney, Agent, or Firm* — Cantor Colburn LLP

(57) **ABSTRACT**

A product dispenser includes a product housing including a drive system and a dispensing apparatus. The drive system includes a motive power device and a controller and is configured to receive energy from an energy supply. The dispensing apparatus is configured to dispense the product. During a condition when the product is being dispensed, the dispensing apparatus is subject to a dispensing resistance and the drive system provides an output to the dispensing apparatus to overcome the dispensing resistance, the output being characterized by a dispensing parameter. The controller receives the dispensing parameter and responsively operates the motive power device, such that the controller operates the motive power device in a first output drive condition in response to the dispensing parameter being below a threshold value, and operates the motive power device in a second output drive condition in response to the dispensing parameter being above a threshold value.

26 Claims, 14 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

7,014,140	B2 *	3/2006	Elliott et al.	242/559.2
7,040,566	B1 *	5/2006	Rodrian et al.	242/563
7,084,592	B2	8/2006	Rodrian	
7,114,676	B2 *	10/2006	Elliott et al.	242/559.2
7,213,782	B2	5/2007	Osborne et al.	
7,370,824	B1 *	5/2008	Osborne	242/563
7,594,622	B2 *	9/2009	Witt et al.	242/563.2
7,874,509	B2 *	1/2011	Kenney	242/563.2
7,984,872	B2 *	7/2011	Kuehneman et al.	242/563.2
8,297,160	B2	10/2012	Friesen et al.	
8,616,489	B2 *	12/2013	Goeking et al.	242/564.4
2002/0109035	A1	8/2002	Denen et al.	
2004/0046082	A1 *	3/2004	Itoh	242/564.1
2005/0167544	A1 *	8/2005	Elliott et al.	242/597.8
2006/0108467	A1 *	5/2006	Elliott et al.	242/559.2
2008/0018302	A1 *	1/2008	Reinsel et al.	320/124
2008/0128446	A1 *	6/2008	Kuehneman et al.	221/10
2009/0272836	A1 *	11/2009	Byrd et al.	242/563
2014/0158809	A1 *	6/2014	Borke	242/563

OTHER PUBLICATIONS

International Search Report and the Written Opinion of the International Searching Authority for International Application No. PCT/US2013/073784; date of mailing Mar. 4, 2014; International Filing Date: Dec. 9, 2013; Applicant: Georgia-Pacific Consumer Products LP; 6 pages.

MOD Brochure for MOD Dispenser System sold by Kimberly-Clark Professional; Undated; www.kcprofessional.com; 7 pages.

* cited by examiner

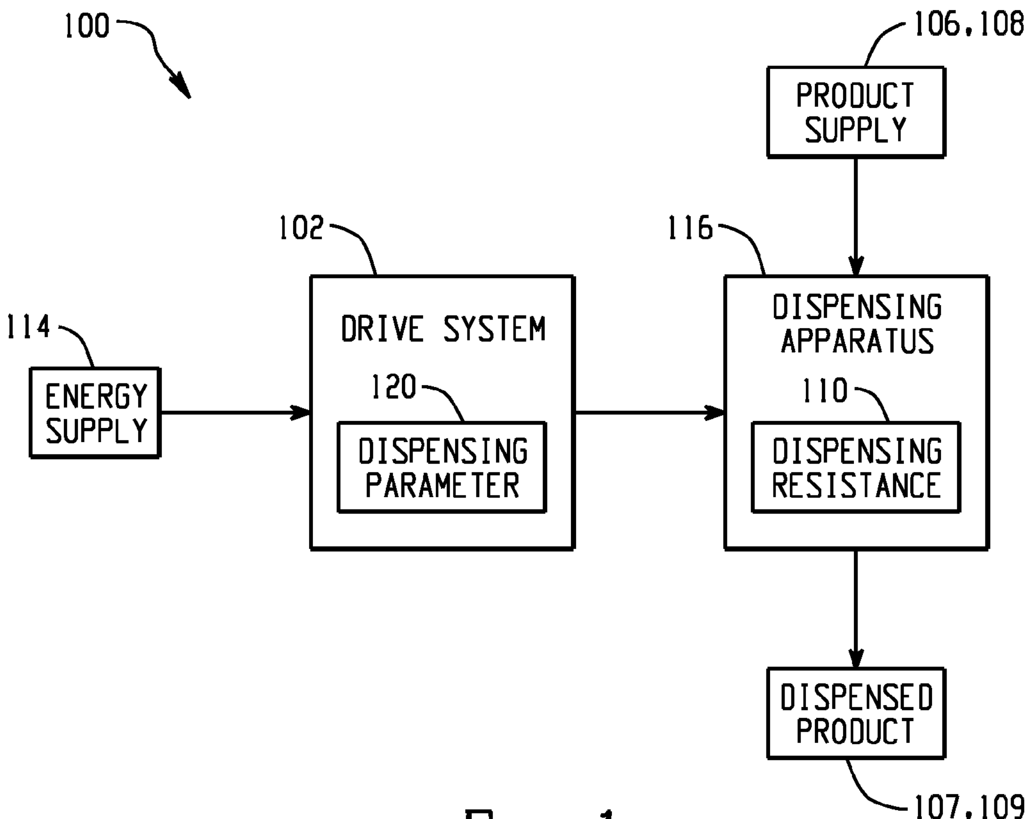

100
106,108
PRODUCT SUPPLY
102
116
DRIVE SYSTEM
DISPENSING APPARATUS
114
ENERGY SUPPLY
120
DISPENSING PARAMETER
110
DISPENSING RESISTANCE
DISPENSED PRODUCT
107,109

Fig. 1

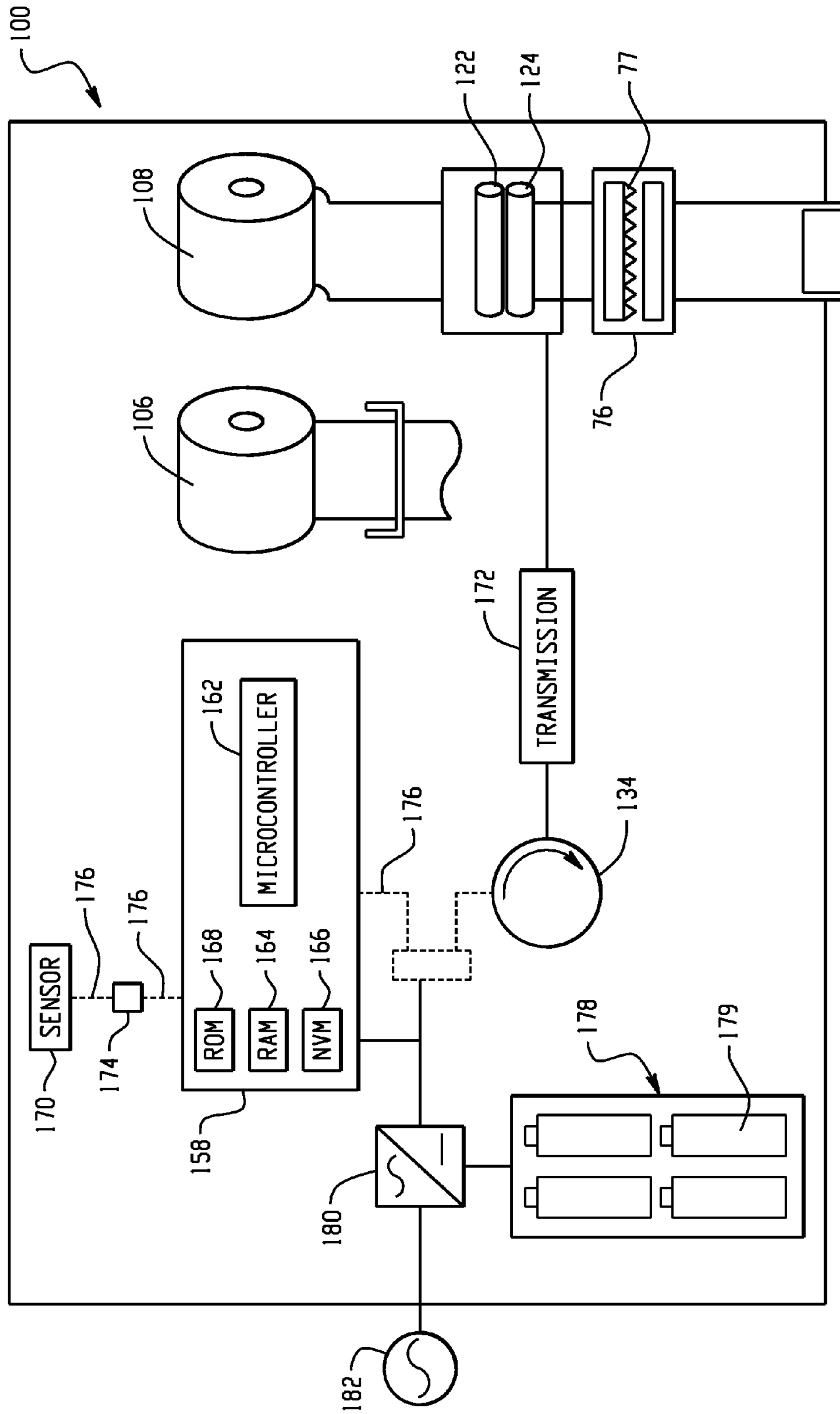

100
108
122
124
77
109
106
76
172
TRANSMISSION
162
MICROCONTROLLER
176
134
SENSOR
168
164
166
ROM
RAM
NVM
174
170
158
178
179
180
182

Fig. 2

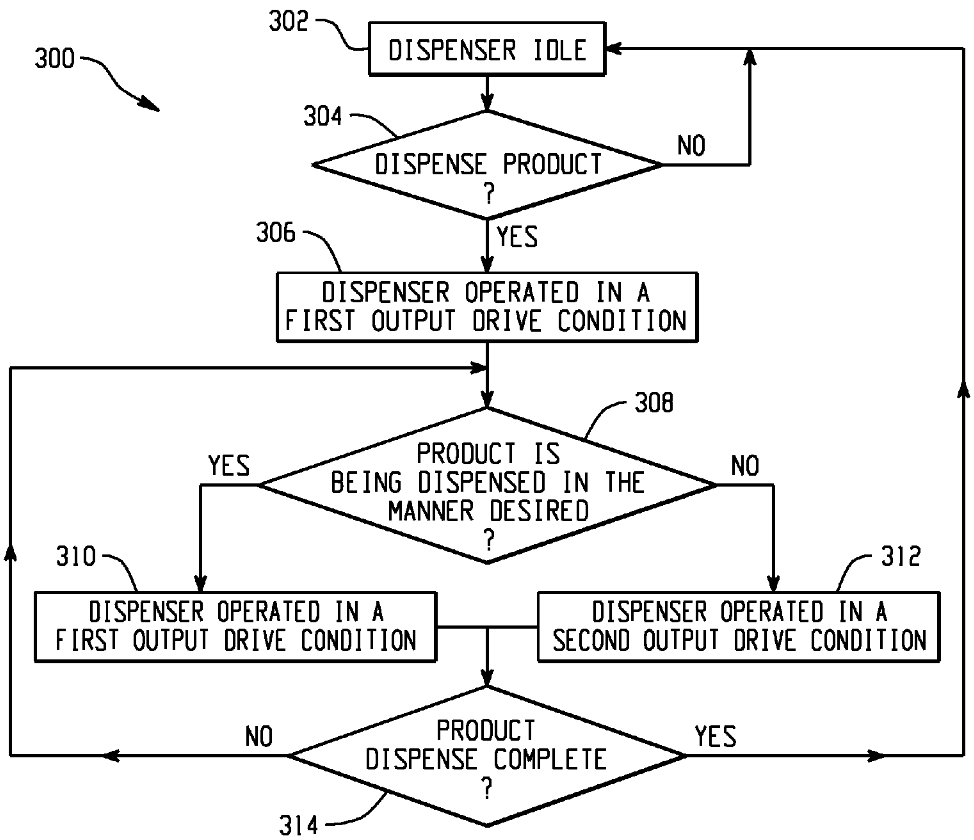

300
302
DISPENSER IDLE
304
DISPENSE PRODUCT ?
NO
YES
306
DISPENSER OPERATED IN A FIRST OUTPUT DRIVE CONDITION
308
PRODUCT IS BEING DISPENSED IN THE MANNER DESIRED ?
YES
NO
310
DISPENSER OPERATED IN A FIRST OUTPUT DRIVE CONDITION
312
DISPENSER OPERATED IN A SECOND OUTPUT DRIVE CONDITION
PRODUCT DISPENSE COMPLETE ?
NO
YES
314

Fig. 3

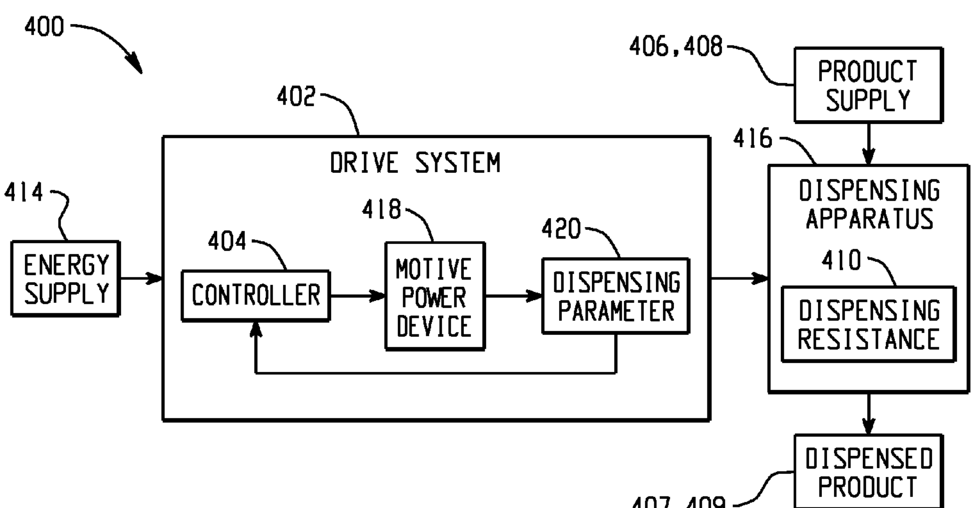

400
402
DRIVE SYSTEM
406,408
PRODUCT SUPPLY
416
414
ENERGY SUPPLY
404
CONTROLLER
418
MOTIVE POWER DEVICE
420
DISPENSING PARAMETER
DISPENSING APPARATUS
410
DISPENSING RESISTANCE
DISPENSED PRODUCT
407,409

Fig. 4

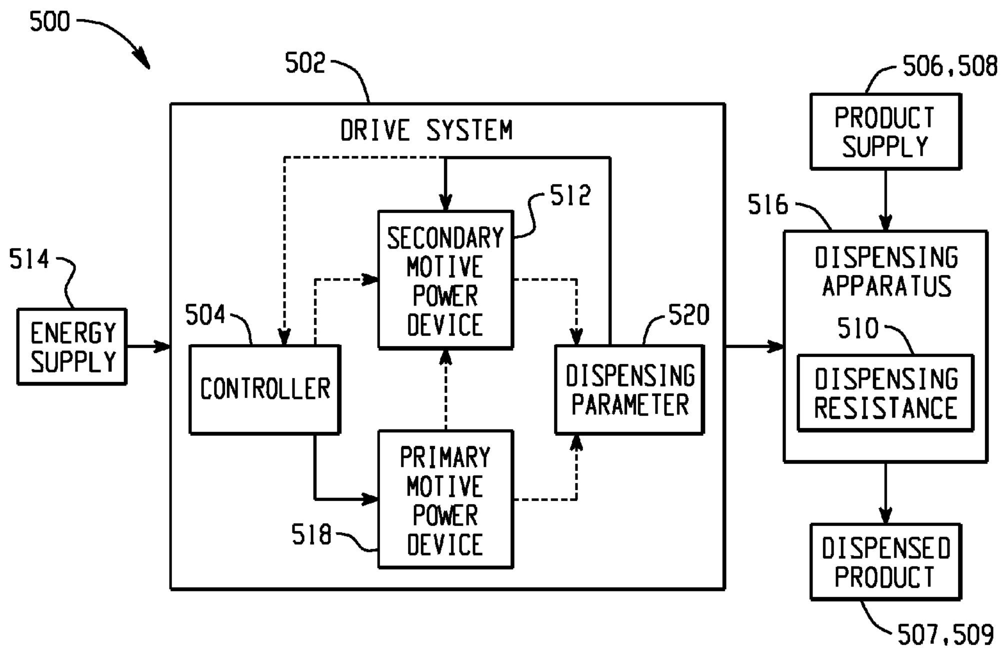

500
502
DRIVE SYSTEM
512
SECONDARY MOTIVE POWER DEVICE
514
ENERGY SUPPLY
504
CONTROLLER
520
DISPENSING PARAMETER
PRIMARY MOTIVE POWER DEVICE
518
506,508
PRODUCT SUPPLY
516
DISPENSING APPARATUS
510
DISPENSING RESISTANCE
DISPENSED PRODUCT
507,509

Fig. 5

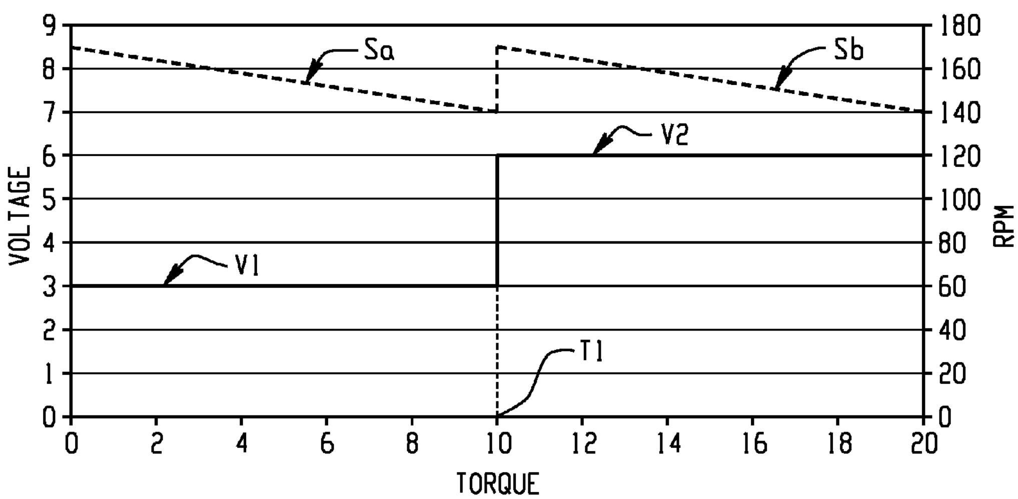

VOLTAGE
RPM
TORQUE
Sa
Sb
V2
V1
T1
0
1
2
3
4
5
6
7
8
9
0
20
40
60
80
100
120
140
160
180
0
2
4
6
8
10
12
14
16
18
20

Fig. 6

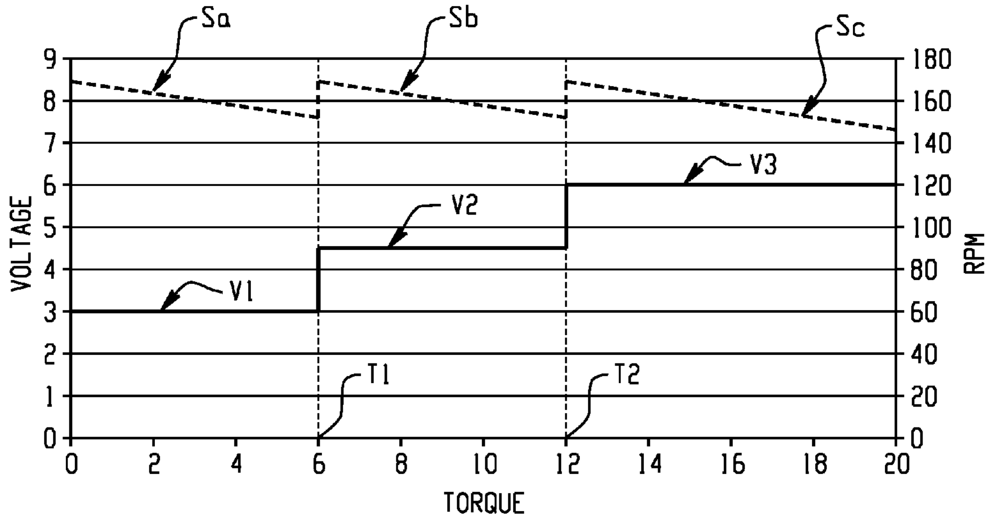

Sa
Sb
Sc
V1
V2
V3
T1
T2
VOLTAGE
RPM
TORQUE
0
1
2
3
4
5
6
7
8
9
0
20
40
60
80
100
120
140
160
180
0 2 4 6 8 10 12 14 16 18 20

Fig. 7

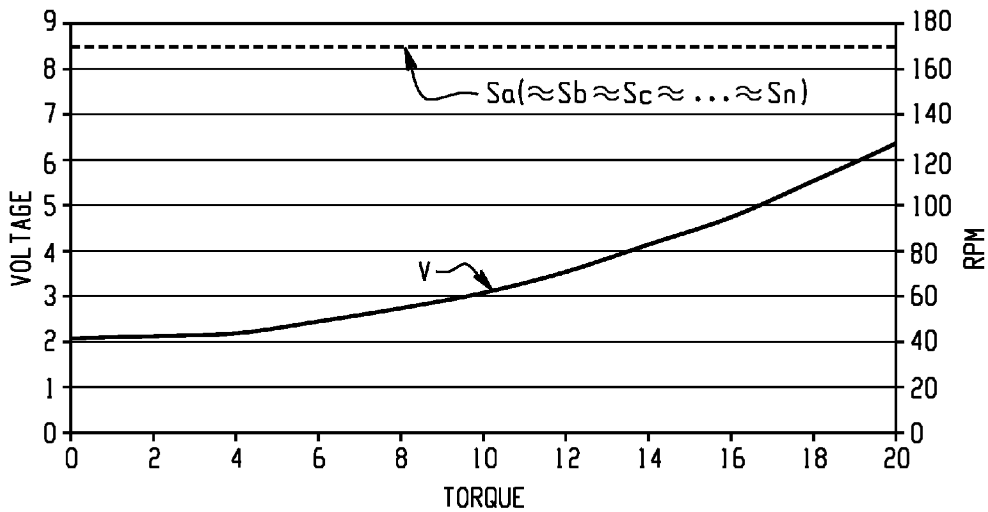
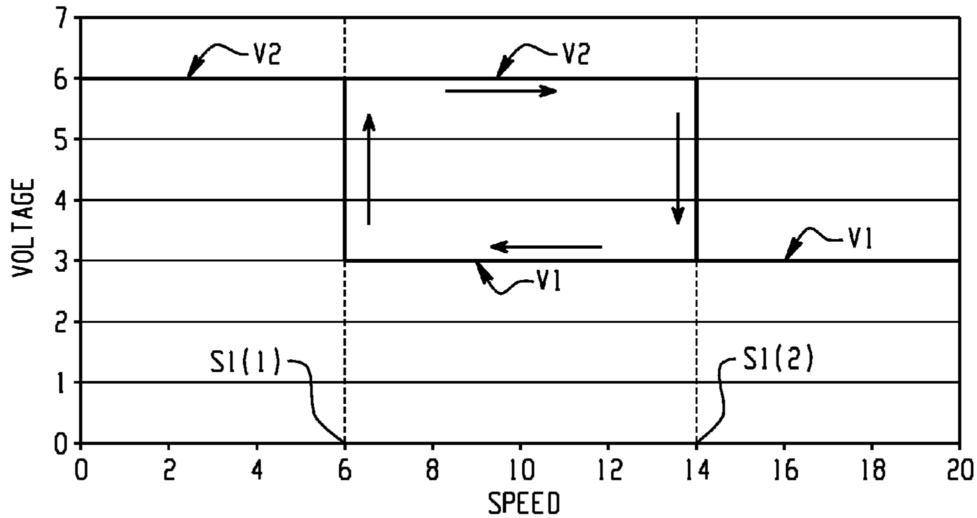
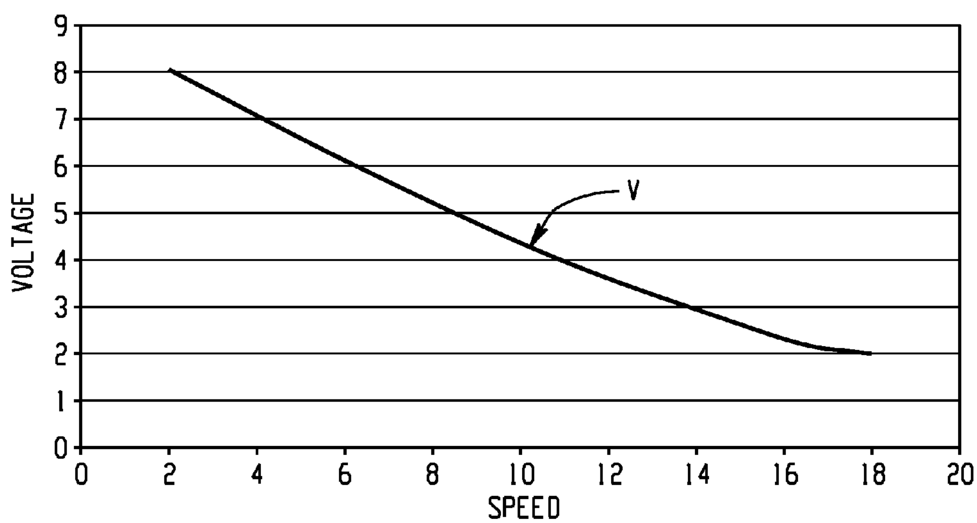

Sa(≈Sb≈Sc≈ ... ≈Sn)
V
VOLTAGE
RPM
TORQUE
0
1
2
3
4
5
6
7
8
9
0
20
40
60
80
100
120
140
160
180
0 2 4 6 8 10 12 14 16 18 20

Fig. 8



VOLTAGE
SPEED
V2
V2
V1
V1
S1(1)
S1(2)
0
1
2
3
4
5
6
7
0
2
4
6
8
10
12
14
16
18
20

Fig. 9



VOLTAGE
SPEED
V
0
1
2
3
4
5
6
7
8
9
0
2
4
6
8
10
12
14
16
18
20

Fig. 10

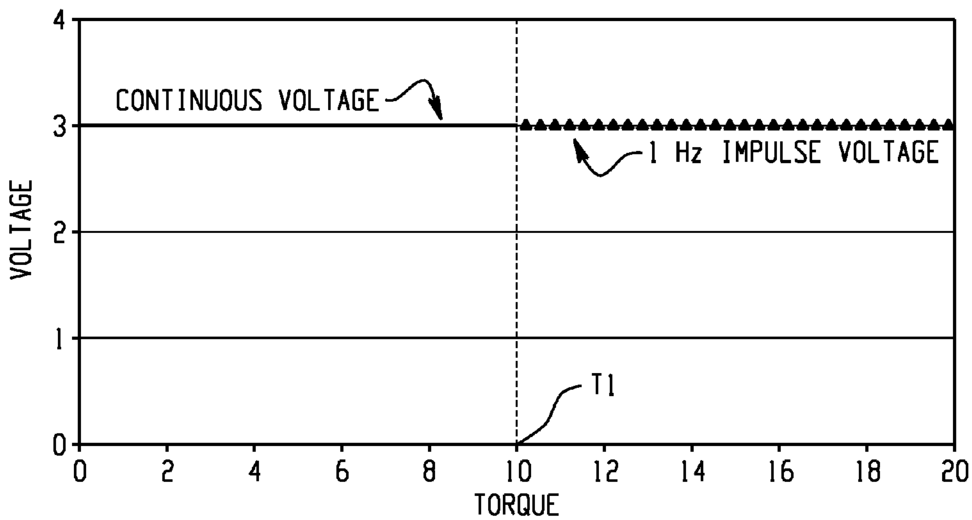

4
3
2
1
0
VOLTAGE
CONTINUOUS VOLTAGE
1 Hz IMPULSE VOLTAGE
T1
0
2
4
6
8
10
12
14
16
18
20
TORQUE

Fig. 11

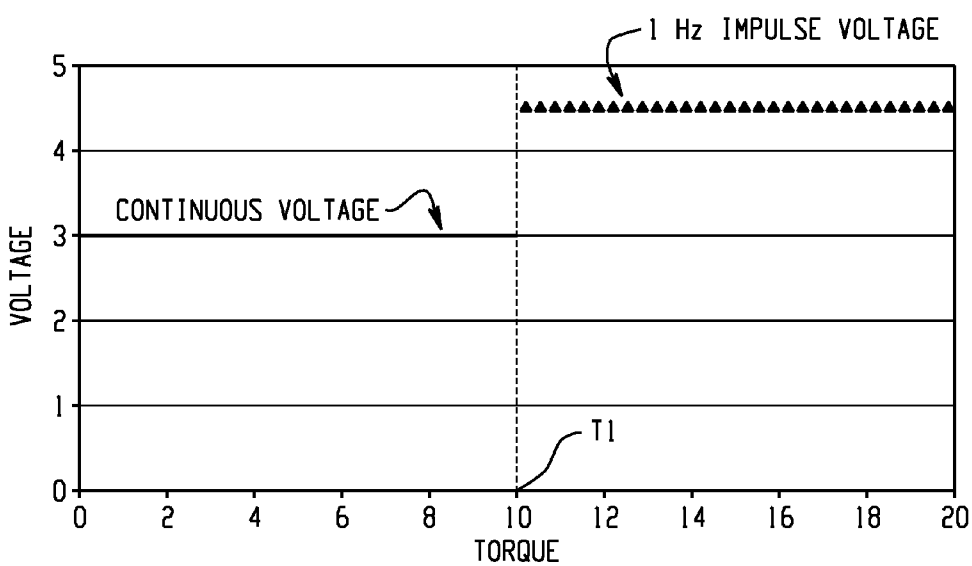

1 Hz IMPULSE VOLTAGE
5
4
3
2
1
0
VOLTAGE
CONTINUOUS VOLTAGE
T1
0
2
4
6
8
10
12
14
16
18
20
TORQUE

Fig. 12

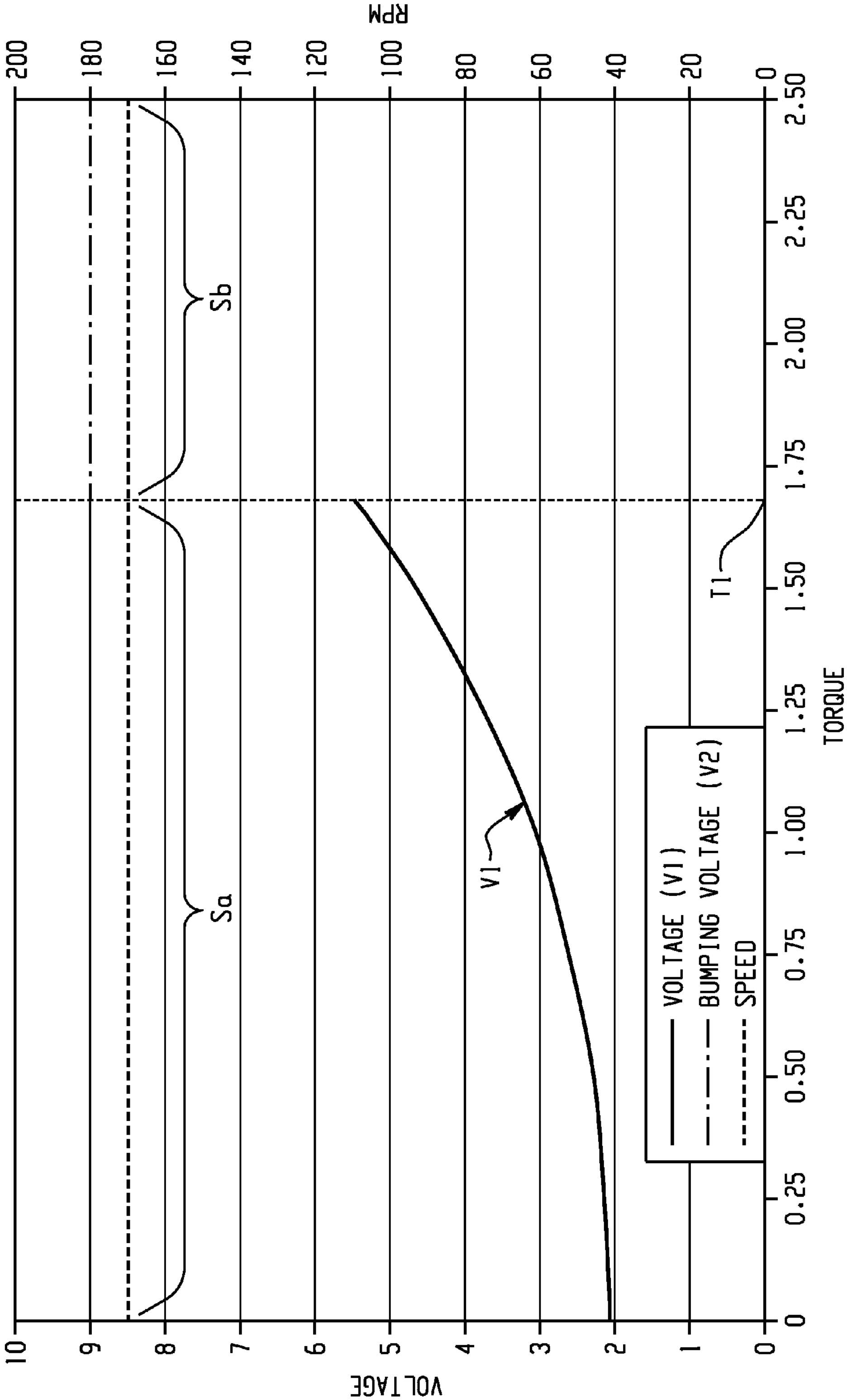

RPM
200
180
160
140
120
100
80
60
40
20
0
VOLTAGE
10
9
8
7
6
5
4
3
2
1
0
TORQUE
0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Sa
Sb
V1
T1
VOLTAGE (V1)
BUMPING VOLTAGE (V2)
SPEED

Fig. 13

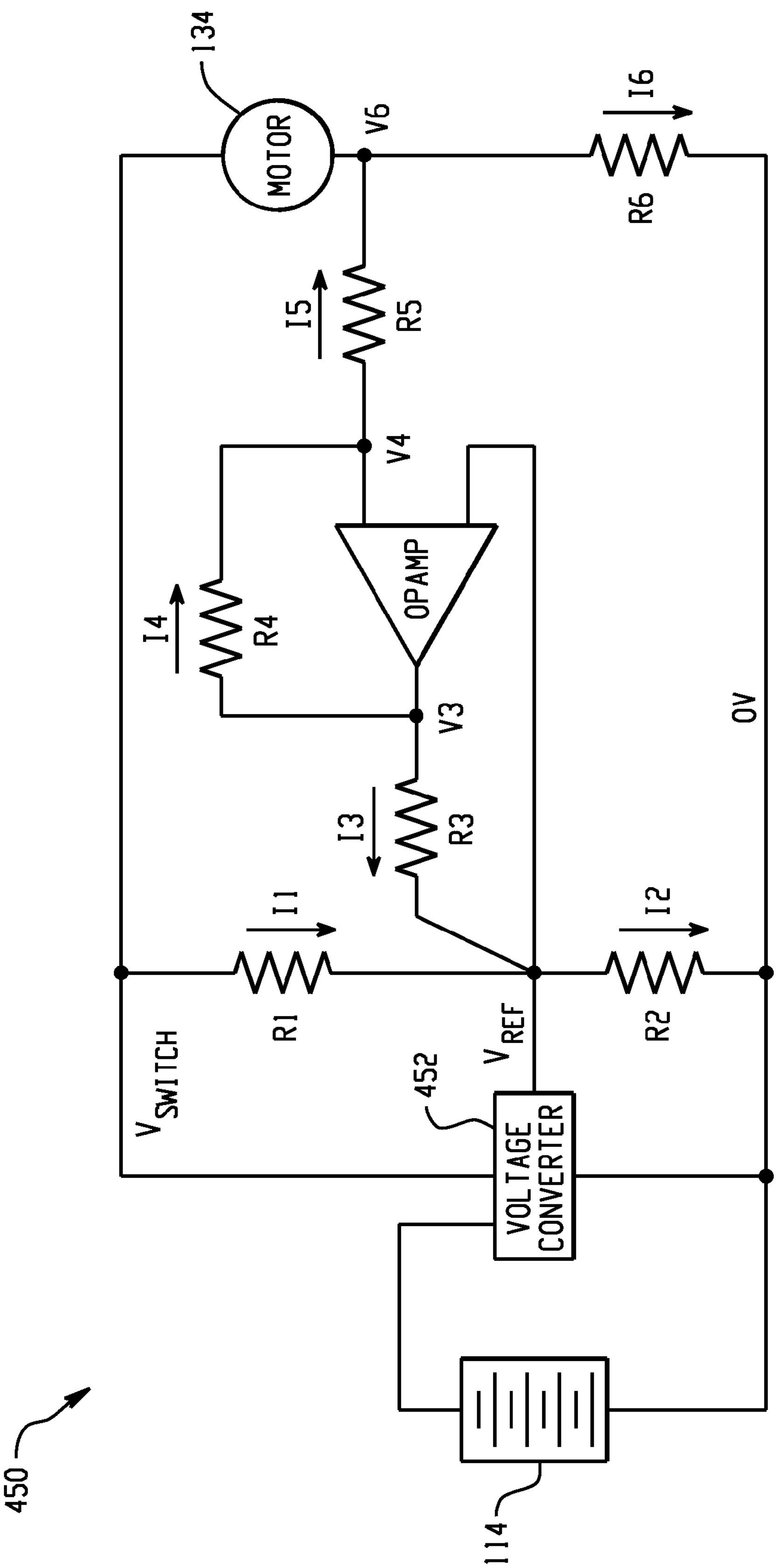

134
MOTOR
V6
I6
R6
I5
R5
V4
OPAMP
I4
R4
V3
0V
I3
R3
I1
R1
I2
R2
V_{REF}
V_{SWITCH}
452
VOLTAGE CONVERTER
114
450

Fig. 14

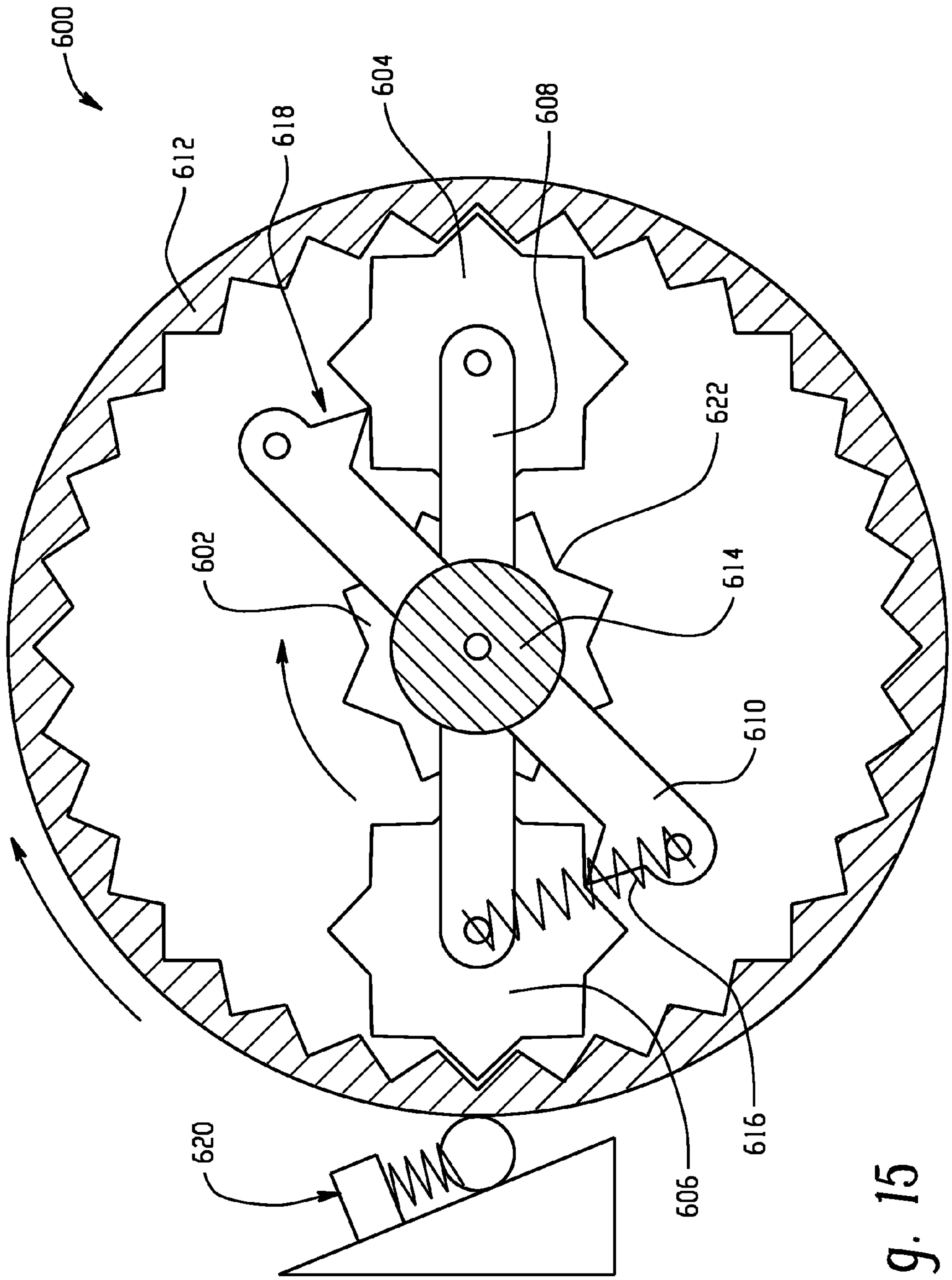


Fig. 15

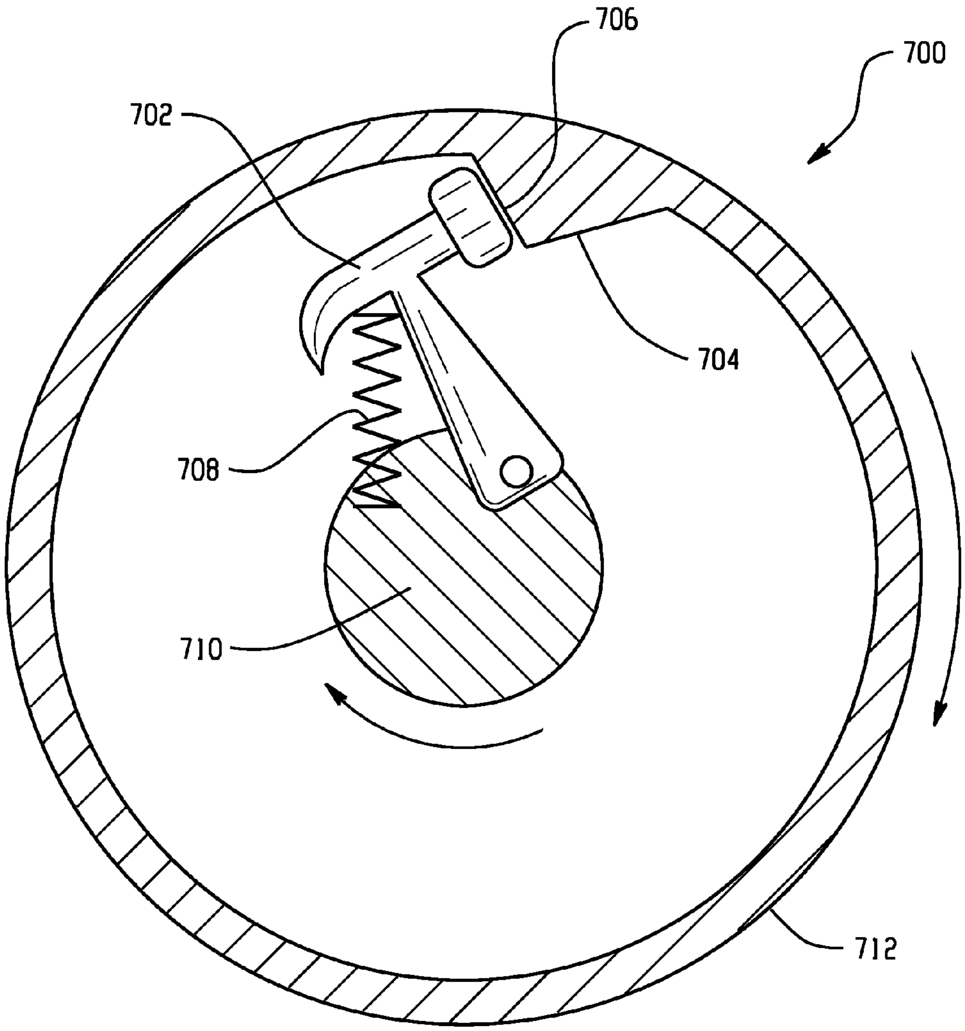


Fig. 16

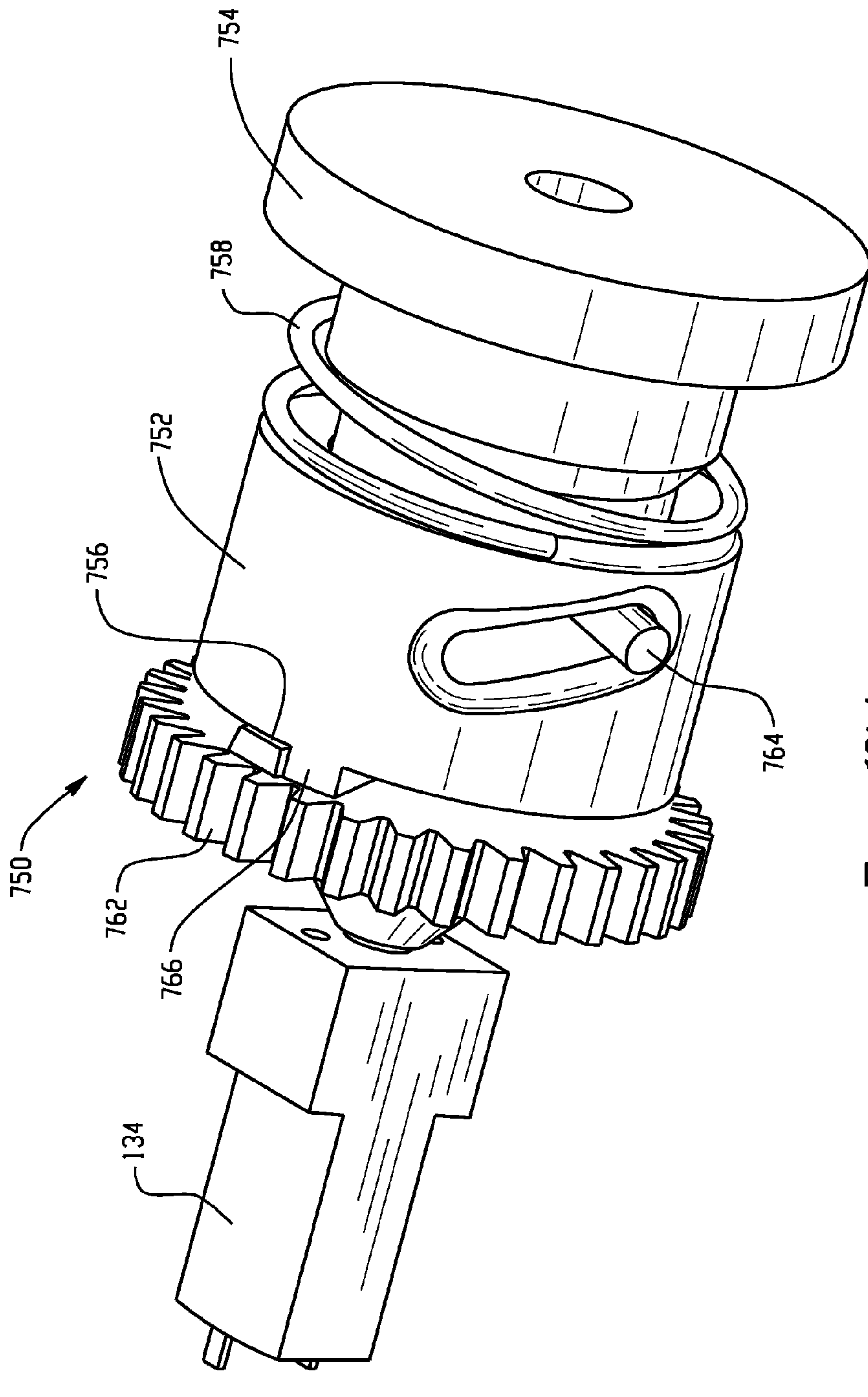


Fig. 17A

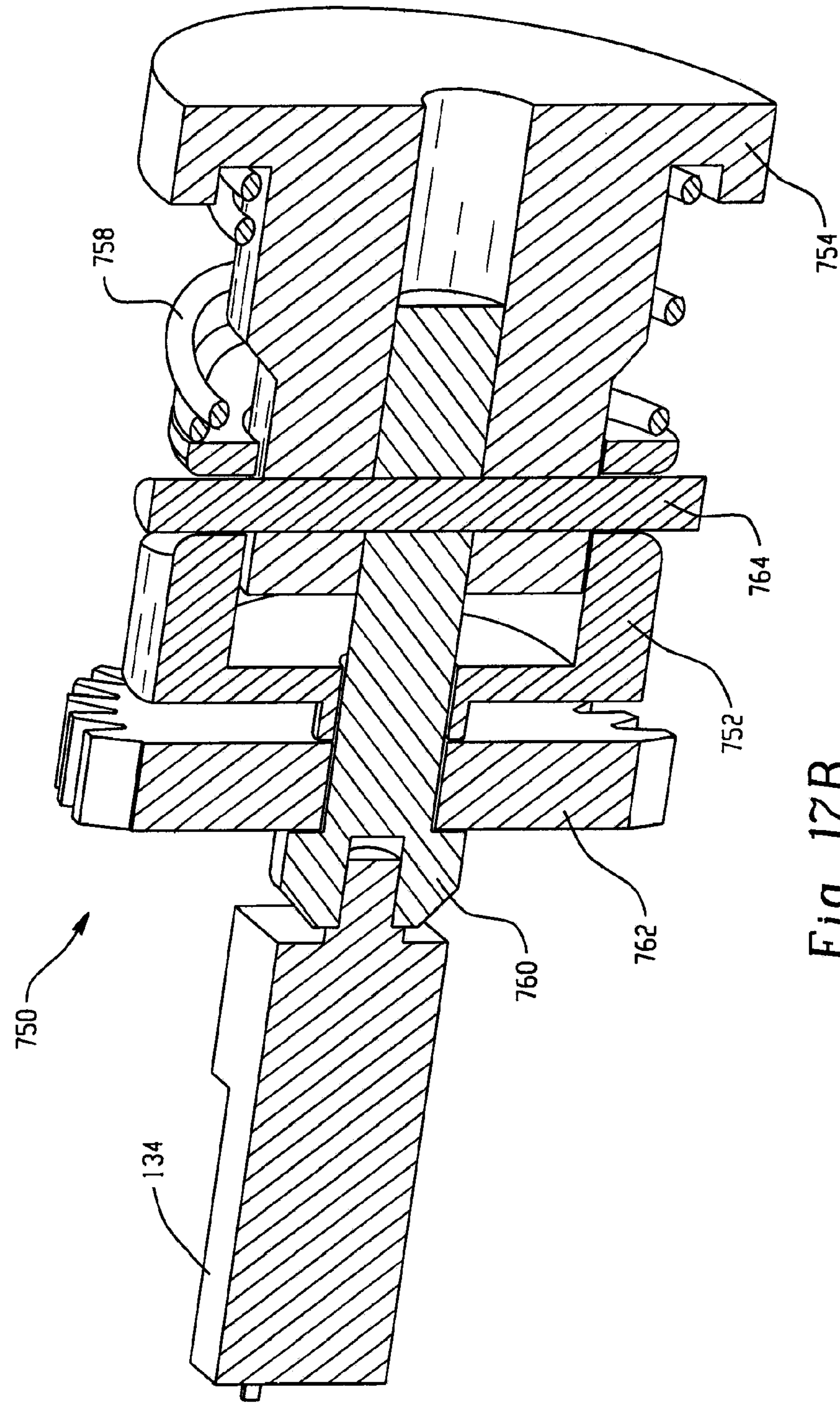
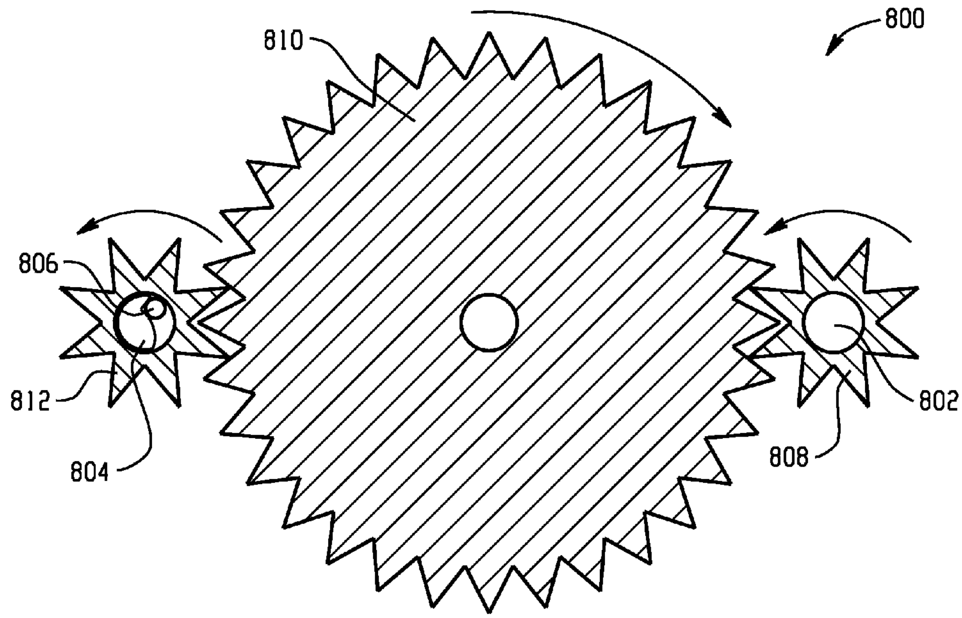
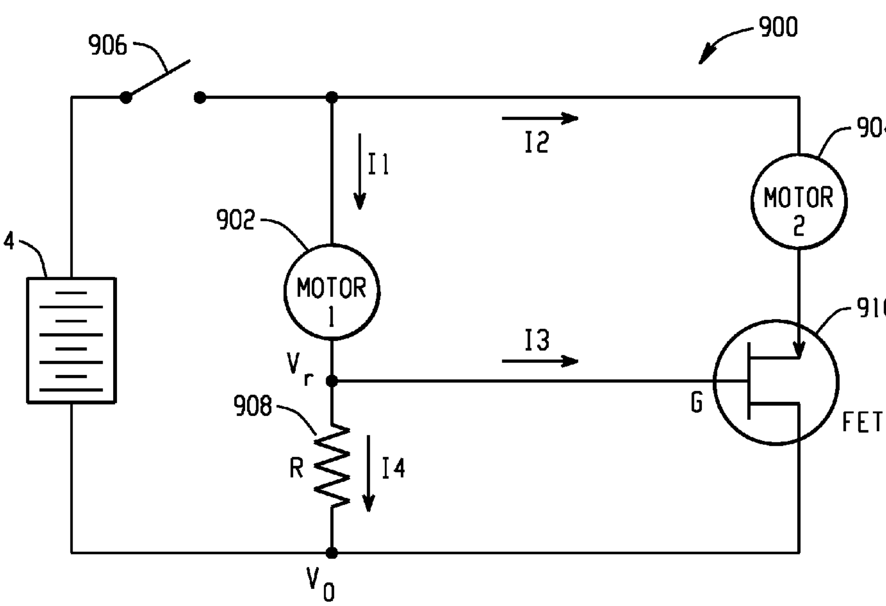


Fig. 17B



800
810
806
812
804
808
802

Fig. 18



900
906
I1
I2
904
MOTOR 2
114
902
MOTOR 1
I3
910
V_r
G
FET
908
R
I4
V_0

Fig. 19

DISPENSER HAVING MORE THAN ONE OUTPUT DRIVE CONDITION

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefits of the legally related U.S. Provisional Patent Application Ser. No. 61/735,594 filed Dec. 11, 2012, which is fully incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present disclosure relates generally to a dispensing apparatus, and more particularly to a product dispensing apparatus having more than one output drive condition.

Product dispensers typically include sheet product dispensers that house multiple rolls of sheet product. The sheet product dispensers are typically arranged to allow maintenance personnel to utilize a partially depleted roll, also referred to as a "stub roll." This partially depleted or stub roll is usually placed in a position to dispense sheet product first to maximize the utilization of sheet product and minimize waste. A second roll, usually a full roll, is also placed within the sheet product dispenser to be used once the stub roll has been depleted.

While some sheet product dispensers merely store the full roll for later manual refilling by maintenance personnel, it is generally preferred to have the full roll automatically dispense once the stub roll is depleted. The automatic dispensing of the full roll allows maintenance personnel responsible for the dispenser to increase the time period between maintenance visits, thus decreasing operating costs and minimizing waste. Sheet product is generally dispensed using a roller system where the sheet product is passed between a drive roller and a pinch roller and the resulting friction pulls the sheet product from the dispensing roll.

The switch from the stub roll to the full roll may be accomplished using a bar that pushes the end (tail portion) of the full roll of sheet product into the rollers. Once the sheet product of the secondary roll has been positioned against the rollers, the resulting friction pulls the sheet product through the rollers and is thereafter dispensed to the user. It is desirable to minimize waste in the operation of the sheet product dispenser to minimize costs. However, it is also desirable to have sheet product available when the user activates the sheet product dispenser. Such requirements often result in double sheeting, where the drive system is set to have the full roll dispense prior to complete depletion of the stub roll, which increases the dispensing resistance. Such requirements may also require breakage of the adhesive holding the sheet product of the stub roll to the axial tube of the stub roll when paper on the stub roll is fully depleted, which also increases the dispensing resistance. In addition, variations in roll diameter, core diameter, product characteristics such as weight, and other dispensing conditions such as wrinkled or crumpled product may increase the dispensing resistance. As such, a dispenser drive system must be capable of overcoming this increased dispensing resistance in order to have sheet product available when the user activates the dispenser.

Typical dispensers address this increased dispensing resistance by utilizing a drive system that is only configured to overcome the highest dispensing resistance, which typically occurs only a fraction of the time the dispenser is used. A drive motor designed to overcome the highest dispensing resistance is unlikely to operate efficiently for the majority of the time where the dispensing resistance is not elevated, thereby resulting in wasted energy.

While existing product dispensers are suitable for their intended purposes, there still remains a need for improvements, particularly regarding the efficiency of operation of the dispenser.

This background information is provided to reveal information believed by the applicant to be of possible relevance to the present invention. No admission is necessarily intended, nor should be construed, that any of the preceding information constitutes prior art against the present invention.

BRIEF DESCRIPTION OF THE INVENTION

An embodiment of the invention is a dispenser, including a product housing configured to receive a product to be dispensed and a drive system including a motive power device and a controller, the drive system configured to receive energy from an energy supply. The dispenser also includes a dispensing apparatus disposed in operable communication with the drive system, the dispensing apparatus configured and disposed in operable communication with the product housing to dispense the product. During a condition when the product is being dispensed the dispensing apparatus is subject to a dispensing resistance and the drive system provides an output to the dispensing apparatus to overcome the dispensing resistance, the output being characterized by a dispensing parameter. The controller receives the dispensing parameter and responsively operates the motive power device, such that the controller operates the motive power device in a first output drive condition in response to the dispensing parameter being below a threshold value, and operates the motive power device in a second output drive condition in response to the dispensing parameter being above a threshold value.

In another embodiment of the invention is a dispenser including a product housing configured to receive a product to be dispensed and a drive system including a primary motive power device and a secondary motive power device, the drive system configured to receive energy from an energy supply. The dispenser also includes a dispensing apparatus disposed in operable communication with the drive system, the dispensing apparatus configured and disposed in operable communication with the product housing to dispense the product. During a condition when the product is being dispensed the dispensing apparatus is subject to a dispensing resistance and the drive system provides an output to the dispensing apparatus to overcome the dispensing resistance, the output being characterized by a dispensing parameter. The secondary motive power device is operably responsive to the dispensing parameter, such that the secondary motive power device operates in a first output drive condition in response to the dispensing parameter being below a threshold value, and operates in a second output drive condition in response to the dispensing parameter being above a threshold value.

In yet another embodiment of the invention is a dispenser including a product housing configured to receive a product to be dispensed and a drive system including a primary motive power device, a secondary motive power device and a controller, the drive system configured to receive energy from an energy supply. The dispenser also includes a dispensing apparatus disposed in operable communication with the drive system, the dispensing apparatus configured and disposed in operable communication with the product housing to dispense the product. During a condition when the product is being dispensed the dispensing apparatus is subject to a dispensing resistance and the drive system provides an output to the dispensing apparatus to overcome the dispensing resistance, the output being characterized by a dispensing parameter. The controller receives the dispensing parameter and responsively operates the secondary motive power device, such that the controller operates the secondary motive power device in a first output drive condition in response to the dispensing parameter being below a threshold value, and operates the secondary motive power device in a second output drive condition in response to the dispensing parameter being above a threshold value.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the exemplary non-limiting drawings wherein like elements are numbered alike in the accompanying Figures:

FIG. **1** depicts a block diagram schematic of a dispenser in accordance with an embodiment;

FIG. **2** depicts a block diagram schematic of a sheet product dispenser in accordance with an embodiment;

FIG. **3** depicts a flowchart of a method for using the dispenser of FIG. **1** in accordance with an embodiment;

FIG. **4** depicts a block diagram schematic of a dispenser configured for electrically increasing the output drive condition in accordance with an embodiment;

FIG. **5** depicts a block diagram schematic of a dispenser configured for mechanically increasing the output drive condition in accordance with an embodiment;

FIG. **6** depicts an input voltage characteristic in accordance with an embodiment;

FIG. **7** depicts another input voltage characteristic in accordance with an embodiment;

FIG. **8** depicts another input voltage characteristic in accordance with an embodiment of the invention;

FIG. **9** depicts another input voltage characteristic in accordance with an embodiment;

FIG. **10** depicts another input voltage characteristic in accordance with an embodiment;

FIG. **11** depicts another input voltage characteristic in accordance with an embodiment;

FIG. **12** depicts another input voltage characteristic in accordance with an embodiment;

FIG. **13** depicts input and output characteristics for substantially constant output speed in accordance with an embodiment; and

FIG. **14** depicts an electric circuit for providing the substantially constant output speed depicted in FIG. **13**.

FIG. **15** depicts an example transmission in accordance with an embodiment;

FIG. **16** depicts an example impulse device in accordance with an embodiment;

FIGS. **17**A and **17**B depicts another exemplary impulse device in accordance with an embodiment;

FIG. **18** depicts an example drive system having a primary motive power device and a secondary motive power device in accordance with an embodiment; and

FIG. **19** depicts an electric circuit for controlling a drive system having a primary motive power device and a secondary motive power device in accordance with an embodiment.

DETAILED DESCRIPTION OF THE INVENTION

Although the following detailed description contains many specifics for the purposes of illustration, anyone of ordinary skill in the art will appreciate that many variations and alterations to the following details are within the scope of the invention. Accordingly, the following preferred embodiments of the invention are set forth without any loss of generality to, and without imposing limitations upon, the claimed invention.

An embodiment of the invention, as shown and described by the various figures and accompanying text, includes a dispenser having a drive system configured to dispense a product under a first situation where the product is dispensed with a first output drive condition from the drive system, and under a second situation where the product is dispensed with a second output drive condition from the drive system, the second output drive condition being sufficient to overcome a higher dispensing resistance that cannot be overcome as quickly, if at all, by the first output drive condition.

While an embodiment described herein depicts a sheet product dispenser as an example dispenser in accordance with an embodiment of the invention, it will be appreciated that the disclosed invention is also applicable to other product dispensers, such as a soap product dispenser, for example. As used herein, the term dispense may include any portion of a full dispense cycle, which includes, but is not limited to, preparing product for a user, delivering product to a user, monitoring product delivery, and monitoring product receipt.

FIG. **1** depicts a block diagram of a dispenser **100** in accordance with an embodiment of the invention. As illustrated, the dispenser **100** includes a drive system **102** coupled to a dispensing apparatus **116**. The drive system **102** receives energy from an energy supply **114** and the dispensing apparatus **116** receives a product to be dispensed from a product supply **106**, **108**. The drive system **102** controls the dispensing of the product **107**, **109** by controlling the operation of the dispensing apparatus **116**. In an embodiment, the dispensed product **107**, **109** may be a sheet product received from a stub roll **108** or a full roll **106**. It will be appreciated that when the full roll **106** provides sheet product to a user, such sheet product is referred to as sheet product **107**. Alternatively, when the stub roll **108** provides sheet product to a user, such sheet product is referred to as sheet product **109**. FIG. **1** illustrates the product supply originating from either the full roll **106** or the stub roll **108**, and illustrates the corresponding dispensed product being sheet product **107**, **109**, respectively.

When a product is being dispensed, a dispensing resistance **110** is experienced by the dispensing apparatus **116**, which may manifest itself in the form of inertia, friction, viscosity, tearing, pressure, interference, or compression for example, and affects the amount of force or torque required from the drive system **102** to dispense the product. An elevated dispensing resistance **110** can occur due to wrinkled product, crumpled product, deformed product, misalignment, dimensional variations, or other reasons. In an embodiment employing a full roll **106** and a stub roll **108**, an elevated dispensing resistance **110** can also occur during depletion of the stub roll **108** and transfer from the stub roll **108** to the full roll **106** for continued sheet dispensing. Such an elevated dispensing resistance **110** may be due to double sheeting, separation of an adhered portion of the end of the sheet product from a spindle of the stub roll **108**, or both, or for other reasons.

In accordance with an embodiment of the invention, and as compared with existing dispensers, overall energy consumption relating to product dispensing can be reduced by configuring the drive system **102** to operate efficiently when the dispensing apparatus **116** is experiencing both a low dispensing resistance condition (such as under normal dispensing of sheet product from the body of the full roll **106** for example) and under an elevated dispensing resistance condition (such as during depletion of the stub roll **108** and transfer from the stub roll **108** to the full roll **106** for example). In an embodiment, during the elevated dispensing resistance condition an increase of torque, force, work, power, or the like is output from the drive system **102** to the dispensing apparatus. Various electrical and mechanical systems for increasing the output of the drive system **102** will be discussed in more detail below.

In exemplary embodiments, the energy supply **114** could be batteries, such as four D-cell batteries for example, or could be an alternating current "AC" power source provided by a utility or other means for example. However, the energy supply could also be provided by a spring, human power, solar power, wind power, or any other device suitable for the purposes disclosed herein. In exemplary embodiments, the drive system **102** may include a motor, actuator, spring, lever, pulley, gear, or any other device or plurality of devices capable of producing work output in a manner suitable for the purposes disclosed herein. In exemplary embodiments, the dispensing apparatus **116** may include a drive roller, a pinch roller, a drive belt, a drive gear, a pump, a plunger, or any other device capable of facilitating dispensing of product in a manner suitable for the purposes disclosed herein

Referring now to FIG. **2**, a block diagram of a dispenser **100** in an embodiment configured for sheet product is shown. It should be appreciated that the illustration in FIG. **2** is for purposes of description and that the presence, relative size, and placement of the respective components may differ. In an embodiment, the sheet product dispenser **100** includes a microprocessor-based main controller **158**, which provides logic and controls functionality used during operation of the sheet product dispenser **100**. Alternatively, the functionality of the main controller **158** may be distributed to several controllers that each provides more limited functionality to discrete portions of the operation of sheet product dispenser **100**. In one embodiment, the main controller **158** is coupled to a drive roller **122** via a motor **134** and an optional transmission assembly **172**. The optional transmission assembly **172**, such as a gearbox for example, adapts the rotational output of the motor **134** for the dispensing of the sheet product from the full roll **106** or the stub roll **108**. Alternatively, the motor **134** may contain an integrated gearbox, commonly known as a gearmotor, and the term "motor" as used herein refers to all motors with or without an integrated gearbox.

In exemplary embodiments, the main controller **158** is a suitable electronic device capable of accepting data and instructions, executing the instructions to process the data, and presenting the results. The main controller **158** may accept instructions through a user interface, or through other means such as but not limited to a proximity sensor, voice activation means, manually-operable selection and control means, radiated wavelength and electronic or electrical transfer. Therefore, the main controller **158** can be, but is not limited to an electrical circuit, a microprocessor, microcomputer, a minicomputer, an optical computer, a board computer, a complex instruction set computer, an ASIC (application specific integrated circuit), a reduced instruction set computer, an analog computer, a digital computer, a molecular computer, a quantum computer, a cellular computer, a solid-state computer, a single-board computer, a buffered computer, a computer network, a desktop computer, a laptop computer, a personal digital assistant (PDA) or a hybrid of any of the foregoing.

The main controller **158** is capable of converting an analog voltage or current level provided by sensors, such as a proximity sensor **170** for example, into a digital signal indicative of a user placing their hand in front of the sheet product dispenser **100**. Alternatively, the proximity sensor **170** may be configured to provide a digital signal to the main controller **158**, or an analog-to-digital (A/D) converter **174** may be coupled between proximity sensor **170** and the main controller **158** to convert the analog signal provided by the proximity sensor **170** into a digital signal for processing by the main controller **158**. The main controller **158** uses the digital signals as input to various processes for controlling the sheet product dispenser **100**. The digital signals represent one or more sheet product dispenser data including but not limited to proximity sensor activation, stub roll empty, tear bar activation, motor current, motor back electromotive force, battery level and the like. It should be appreciated that in some embodiments, the main controller **158** may be arranged to also include one or more direct analog inputs to receive one or more analog signals instead of or in addition to digital signals.

In exemplary embodiments, the main controller **158** is operably coupled with one or more components of sheet product dispenser **100** by data transmission media **176**, which includes, but is not limited to, solid-core wiring, twisted pair wiring, coaxial cable, and fiber optic cable. The data transmission media **176** also includes, but is not limited to, wireless, radio and infrared signal transmission systems. The main controller **158** is configured to provide operating signals to these components and to receive data from these components via the data transmission media **176**. The main controller **158** communicates over the data transmission media **176** using a well-known computer communications protocol such as Inter-Integrated Circuit (I2C), Serial Peripheral Interface (SPI), System Management Bus (SMBus), Transmission Control Protocol/Internet Protocol (TCP/IP), RS-232, ModBus, or any other communications protocol suitable for the purposes disclosed herein.

In an embodiment, the electrical energy for operating the sheet product dispenser **100** is provided by a battery **178**, which may be comprised of one or more batteries arranged in series or in parallel to provide the desired energy. In an embodiment, the battery **178** includes four 1.5-volt "D" cell batteries **179**. The battery **178** is connected to the main controller **158** via an optional power converter **180** that adapts the electrical output of the battery **178** to that desired for operating the sheet product dispenser **100**. The optional power converter **180** may also accept an input from an external power source, such as an alternating current ("AC") power source **182** or a solar power source, or any other alternative power source as may be appropriate for an application. The AC power source **182** may be any conventional power source, such as a 120V, 60 Hz wall outlet for example.

A tear bar assembly **76**, which includes a serrated tear bar **77**, is positioned adjacent the dispensing chute to provide a means for separating the dispensed sheet product from the stub roll **108** or the full roll **106**, depending on which roll is, or if both rolls are, actively involved in the dispensing of sheet product.

Referring now to FIG. **3**, a flow chart illustrating a method **300** for controlling the dispenser **100** in accordance with an embodiment is shown. At block **302**, which represents the start of the method **300**, the dispenser **100** is idle. As shown at decision block **304**, the dispenser **100** determines whether it should be dispensing product. In exemplary embodiments, the dispenser **100** may determine if it should be dispensing a product by receiving a signal from a proximity sensor. If the dispenser **100** should be dispensing product, then the method **300** advances to block **306** where the drive system **102** of dispenser **100** is operated in a first output drive condition in an effort to dispense product. In exemplary embodiments, the first output drive condition is configured to be able to dispense product from the dispenser **100** during normal operating conditions of the dispenser **100**. Next, as shown at decision block **308**, the dispenser **100** determines if the product is being dispensed in a manner desired. In exemplary embodiments, when operating in the first output drive condition the dispenser may not be able to dispense the product in the manner desired due to an elevated dispensing resistance **110**. For example, if the dispenser **100** is dispensing the product at or above a desired speed, the dispenser **100** might be considered to be dispensing in the manner desired. If the product is being dispensed in the manner desired, the dispenser **100** continues to operate in the first output drive condition, as shown at block **310**. If the product is not being dispensed in the manner desired, the dispenser is operated in a second output drive condition, as shown at block **312**. In exemplary embodiments, the second output drive condition is configured to be able to dispense product from the dispenser **100** when the dispenser **100** is experiencing an elevated dispensing resistance **110**. As shown at decision block **314**, while the dispenser **100** is being operated in either the first or second output drive condition the dispenser **100** determines if the product dispense cycle is complete. Once the product dispense has been completed, the dispenser **100** is again idle, as shown at block **302**. Otherwise, the dispenser **100** continues to monitor if the product is being dispensed in the manner desired, as shown at decision block **308**.

In one embodiment, during the first output drive condition a first level of torque can be applied to the drive roller **122** from the drive system **102** and during the second output drive condition a second level of torque, which is greater than the first level of torque, can be applied to the drive roller **122** from the drive system **102**. In exemplary embodiments, an output drive condition may result in a force, speed, pressure, work, power, or any other output drive condition producible by the dispenser **100**. As used herein, the torque, force, speed, pressure, work, power, or other condition required to overcome dispensing resistance **110** are collectively referred to as dispensing parameters **120** associated with the product being dispensed. That is, if the product being dispensed is a roll of sheet product via a drive roller **122**, then the dispensing parameter **120** may be the torque required to unroll the sheet product (torque resistance against the drive roller **122** of the dispensing apparatus **116**), and if the product being dispensed is a soap via a pump, then the dispensing parameter **120** may be the pressure required to pump the soap out of a reservoir.

As will be appreciated from the foregoing, the dispensing parameter **120** being monitored by the dispenser **100** may be the torque required by the dispensing apparatus **116** to dispense the product. For example, where the monitored torque provided to the dispensing apparatus **116** has a value less than a threshold torque, the dispensing apparatus **116** is operating against a low dispensing resistance **110** and when the monitored torque provided to the dispensing apparatus **116** is greater than the threshold torque the dispensing apparatus **116** is operating against an elevated dispensing resistance **110**. In exemplary embodiments, the drive system **102** is configured to operate in a first output drive condition when a low dispensing resistance is detected and in a second output drive condition when an elevated dispensing resistance is detected.

Also from the foregoing, it will be appreciated that in exemplary embodiments the dispensing parameter **120** being monitored could be a dispensing speed. For example, where the monitored dispensing speed has a value higher than a threshold speed, the dispensing apparatus **116** is operating against a low dispensing resistance **110** and when the monitored dispensing speed is less than the threshold speed the dispensing apparatus **116** is operating against an elevated dispensing resistance **110**. In exemplary embodiments, the drive system **102** is configured to operate in a first output drive condition when a low dispensing resistance is detected and in a second output drive condition when an elevated dispensing resistance is detected.

In exemplary embodiments, the dispenser **100** can utilize functionality of the main controller **158** to determine whether to implement the first output drive condition or the second output drive condition. However, in other exemplary embodiments, the dispenser **100** may utilize one or more mechanical schemes or analog circuit control schemes to determine whether to implement the first output drive condition or the second output drive condition. In exemplary embodiments, various electrical and mechanical methods and systems can be utilized for implementing the first output drive condition and the second output drive condition.

Referring now to FIG. **4**, a block diagram of a dispenser **400** configured for electrical control of the output drive condition of the dispenser **400** in accordance with an embodiment of the invention is shown. The drive system **402** receives power from the energy supply **414** and delivers conditioned power to the motive power device **418**. In addition, a controller **404** may be configured to receive a signal indicating that the dispenser should be activated and responsively instruct the motive power device **418** to dispense a product. In exemplary embodiments, a controller **404** can be configured to perform power conditioning on the supplied power and to provide conditioned power to the motive power device **418**. For example, the controller **404** may receive a twelve volt power signal and may use pulse width modulation techniques, voltage conversion techniques, or other techniques to provide an equal or lower power signal to the motive power device **418**. In addition, the controller **404** receives one or more signals indicative of the dispensing parameter **420** being produced by the motive power device **418**. Based on the dispensing parameter **420**, the controller **404** responsively controls the power provided to the motive power device **418** thereby controlling the mode of operation of the drive system **402**. In exemplary embodiments, the dispensing parameter **420** may be the torque, rotational force, or speed produced by the motive power device **418**. In one embodiment, the motive power device **418** may be a motor **134** and the dispensing parameter **420** may be a back EMF voltage produced by the motor **134**.

Referring now to FIG. **5**, a block diagram is shown of a dispenser **500** configured for one or more mechanical schemes of implementing the output drive condition of the dispenser **500** in accordance with an embodiment of the invention is shown. The drive system **502** may include a controller **504** that may be configured to receive power from the energy supply **514**, perform power conditioning on the supplied power, and deliver conditioned power to the primary motive power device **518** and/or the secondary motive power device **512**. In addition, the controller **504** may be configured to receive a signal indicating that the dispenser should be activated and responsively instruct the primary motive power device **518** to dispense a product. In exemplary embodiments, the primary motive power device **518** may include a motor, actuator, spring, lever, pulley, or any other device or plurality of devices capable of producing work output in a manner suitable for the purposes disclosed herein. In addition, the secondary motive power device **512** may include a motor, actuator, spring, lever, pulley, one-way bearing, transmission, gear, mechanical impact device, or any other device which is configured to operate differently, if at all, during a second output drive condition as compared to a first output drive condition. The drive system **502** is configured to monitor a dispensing parameter **520** that it is producing and to responsively control the mode of operation of the secondary motive power device **512**. In exemplary embodiments, the dispensing parameter **520** may be the torque, rotational force or speed produced by the drive system **502** and provided to the dispensing apparatus **516**.

Electrical Control

In one embodiment, such as depicted in FIG. **4**, during a first output drive condition a first voltage is supplied from the controller **404** to the motive power device **418** and during a second output drive condition a voltage greater than the first voltage is supplied by the controller **404** to the motive power device **418**, thereby causing the motive power device **418** to generate a larger output torque. Referring now to FIGS. **6-8**, graphs illustrating various multi-drive condition schemes are shown where the controller **404** monitors a dispensing parameter **420**, such as a speed or torque produced by the motive power device **418**, to determine whether to operate in the first output drive condition or the second output drive condition.

In the embodiment depicted by FIG. **6**, the dispensing parameter is the torque that the motive power device **418**, such as a motor **134**, is producing to overcome dispensing resistance **110**. A torque threshold T**1** is depicted having a torque value of 10 torque units. If the torque required for dispensing product is less than 10, then the controller **404**, or other electrical circuit suitably configured for the purpose disclosed herein, provides a first voltage V**1** of 3V to the motive power device **418**, and if the torque required is greater than 10, then the controller **404** provides a second voltage V**2** of 6V to the motive power device **418**. In one embodiment, the first voltage V**1** of 3V may result in a dispensing speed Sa between 140 to 170 rpm, the second voltage V**2** of 6V may result in a dispensing speed Sb between 140 to 170 rpm, i.e., Sa and Sb are substantially equal. Notwithstanding the foregoing example, it will be appreciated that the illustrated threshold torque value of 10 torque units, the illustrated input voltage levels of 3V and 6V, and the illustrated dispensing speed of 140 to 170 rpm, are arbitrary values for discussion purposes only, and that the scope of the invention is not limited to any particular torque threshold value T**1**, any particular input voltage levels, or any particular dispensing speeds.

In the embodiment depicted by FIG. **7**, there are two torque thresholds T**1** and T**2**, where T**1** is depicted having a torque value of 6 torque units, and T**2** is depicted having a torque value of 12 torque units. If the torque required for dispensing product is less than 6, then the controller **404** provides a voltage V**1** of 3V to the motive power device **418** resulting in a dispensing speed Sa between 152 rpm and 170 rpm; if the torque required is between 6 and 12, then the controller **404** provides a voltage V**2** of 4.5V to the motive power device **418** resulting in a dispensing speed Sb between 152 rpm and 170 rpm; and, if the torque required is greater than 12, then the controller **404** provides a voltage V**3** of 6V to the motive power device **418** resulting in a dispensing speed Sc between 146 rpm and 170 rpm. In this embodiment, the dispensing speeds Sa, Sb, and Sc are more substantially equal to each other as compared to the embodiment depicted by FIG. **6**, thereby providing a perceptibly more consistent dispensing operation.

In the embodiment depicted by FIG. **8**, there are an infinite number of torque thresholds, or alternatively, there are a defined number of discrete torque thresholds arranged along a continuum (discrete points along the curve of FIG. **8** for example). As the torque required for dispensing increases above one of the discrete thresholds, the controller **404** provides an increased voltage V to the motive power device **418**, resulting in a substantially constant, continuous dispensing speed Sa. The curve of FIG. **8** may be analog-based, where the voltage V to the motive power device **418** varies functionally with the sensed torque, or digital-based, where the voltage V to the motive power device **418** varies according to a defined set of x-y data points used to define the curve of FIG. **8**, which may be accessed by the controller **404** via a lookup table stored in memory **164**, **166** or **168** for example.

From the foregoing description of FIGS. **6**, **7**, and **8** relating to voltage as a function of torque, and from the foregoing description of speed being a suitable dispensing parameter, it will be appreciated that an alternate embodiment employing speed as opposed to torque as a dispensing parameter may also be employed. In the embodiment depicted in FIG. **9**, there are two speed thresholds S**1**(**1**) and S**1**(**2**) where S**1**(**1**) is depicted having a speed threshold of 6 speed units and S**1**(**2**) is depicted having a speed threshold of 14 speed units. If the speed at which product is dispensed is above 14 units, then the controller **404** provides a voltage V**1** of 3V to the motive power device **418**. As dispensing resistance **410** increases, dispensing speed will decrease. If dispensing speed decreases below the threshold S**1**(**1**), then the controller **404** provides a voltage V**2** of 6V to the motive power device **418** until dispensing resistance **410** subsides and the voltage V**2** causes the dispensing speed to exceed the threshold S**1**(**2**), at which time the controller **404** provides a voltage V**1** of 3V to the motive power device **418**.

In the embodiment depicted in FIG. **10**, there are an infinite number of speed thresholds, or alternatively, a defined number of discrete speed thresholds arranged along a continuum (similar to the discrete points along the curve of FIG. **8**, but where the voltage increases as the speed decreases, for example). As with a system utilizing a torque dispensing parameter, in a system utilizing a speed dispensing parameter the controller **404** will control the voltage to the motive power device **418** according to the established characteristic curve.

In exemplary embodiments, during the first output drive condition a first voltage is applied to the motive power device **418** and during the second output drive condition the voltage applied to the motive power device **418** may be bumped, thereby causing the motive power device **418** to generate an impulse output torque. In various exemplary embodiments, the voltage applied during the second output drive condition the applied voltage may be equal to or greater than the voltage applied during the first output drive condition. The input impulses may be separated by enough time to allow the dispensing apparatus **416** in FIG. **4** to receive the input impulses as discrete, individual events, instead of events that occur so frequently as to appear to the dispensing apparatus **416** as one average, continuous event. As such, the separation time can allow the input impulses to initially generate and accumulate energy within a slack condition in the dispensing apparatus **416**, whereby the energy is later released during the input impulse duration as a “jerk”, or a “kick”, or a similar higher peak output drive condition sufficient to overcome an elevated dispensing resistance **410**.

Referring now to FIG. **11**, an embodiment employing a pulsing function as noted above is shown. As illustrated, a torque threshold T**1** is depicted with a value of 10. If the torque required for dispensing is less than 10, then the controller **404** provides a continuous voltage of 3V to the motive power device **418**. If T is greater than 10, then the controller **404** provides a series of impulse cycles alternating between 0V and 3V at 1 Hertz to the motive power device **418**, each impulse voltage pulse lasting a duration of 500 msec. FIG. **12** shows an embodiment employing another pulsing function as noted above. In this embodiment, a torque threshold T**1** is depicted with a value of 10. If the torque required for dispensing is less than 10, then the controller **404** provides of continuous voltage of 3V to the motive power device **418**. If the torque required for dispensing is greater than 10, then the controller **404** provides a series of increased voltage impulse cycles alternating between 0V and 4.5V at 1 Hertz to the motive power device **418**, each impulse voltage pulse lasting a duration of 500 msec. While values such as 3V continuous, 3V impulse, 4.5V impulse, 1 Hertz, and 500 msec are discussed herein, it will be appreciated that these values are for discussion purposes only, and are not and should not be considered limiting in any way to the invention disclosed herein.

With reference back to FIG. **3**, at decision block **308**, the dispenser determines if the dispenser operating in the first output drive condition is dispensing the product in the manner desired, that is, if the dispensing resistance against the dispensing apparatus in the first output drive condition is less than a threshold condition T**1**, as shown in FIGS. **11** and **12**. If the dispenser is dispensing the product in the manner desired, then the method **300** progresses to block **310** where a continuous input is provided to the motive power device. If the dispenser is not dispensing the product in the manner desired, then the method **300** progresses to block **312** where a discontinuous, or bumped, or non-uniform, input, such as an impulse voltage (FIG. **11**) or an elevated impulse voltage (FIG. **12**), is provided to the motive power device.

In another exemplary embodiment, the dispenser **100** may include a circuit to drive the dispensing apparatus at a second speed resulting from an elevated voltage input to the motive power device, which is substantially equal to a first speed of the dispensing apparatus that results without the need for an elevated voltage input to the motive power device. As used herein with respect to speed, the term "substantially" is intended to take into consideration slight variations in speed that are not readily discernible to an end user.

Referring now to FIG. **13**, input to and output from a motive power device is depicted that would allow the drive system to operate at a substantially constant speed during a dispense operation, and to achieve sufficient torque and/or impulse output to generate the torque requirements for both a normal dispensing operation and a higher-resistance operation such as a roll transfer operation. In an embodiment, the input voltage is a continuous voltage V**1**, which may be constant, or variable as depicted, for conditions where the dispensing resistance **110** is less than a threshold value and is a non-continuous or non-uniform impulse (bumping) voltage V**2** for conditions where the dispensing resistance is greater than a threshold value. As depicted, the output speed of the drive system is a substantially constant first speed Sa in response to the V**1** input condition, and is contemplated to be a constant average second speed Sb in response to the V**2** input condition. However, it is also contemplated that the average second speed Sb may not be constant, but may functionally vary with factors including the bumping voltage V**2**, bumping duration, motor current draw, and the dispensing resistance. As depicted, the second speed Sb is contemplated to be substantially the same as the first speed Sa.

It will be appreciated by one skilled in the art that the continuous voltages and the non-continuous, non-uniform voltages depicted in FIGS. **6** through **13** can be achieved by using pulse-width modulation (PWM) techniques.

FIG. **14** depicts an embodiment of a circuit **450** suitable for achieving a substantially constant dispensing speed by producing a voltage that increases with motor current draw as depicted by voltage V**1** in FIG. **13**. Power supply **114** provides an input voltage to a voltage converter **452** such as a buck converter, a boost converter, a buck/boost converter, or the like. The voltage converter **452** uses the input voltage to produce an output, Vswitch, which will maintain the node Vref at a prescribed voltage, such as 1.24V. The reference voltage Vref is also connected to voltage V**4** through an operational amplifier (opamp). The opamp produces an output voltage V**3** as necessary to keep the terminal voltage V**4** equal to Vref. During a condition when dispensing resistance is at a maximum, the current draw through the motor and resistor R**6** is high, causing the voltage V**6** to be high, such as 1.24V. During this condition, the opamp produces a voltage V**3** of 1.24V so that there is no current I**4** and I**5** through resistors R**4** and R**5**, which is a necessary condition to maintain V**4** at Vref (1.24V). Since the opamp produces a voltage V**3** of 1.24V, there is no current I**3** through resistor R**3**. Therefore, the voltage converter must produce a voltage Vswitch high enough to produce enough current I**1** through resistor R**1** to maintain Vref at 1.24V. As such, the motor **134** receives the high voltage, Vswitch. As the dispensing resistance decreases, the motor current, current I**6**, and voltage V**6** all decrease. The opamp increases the voltage of V**3** in order to produce a current I**4** and I**5** that will maintain voltage V**4** equal to Vref of 1.24V. As the opamp increases voltage V**3**, current I**3** through resistor R**3** will increase. As much as current I**3** increases, current I**1** must similarly decrease in order to maintain a voltage Vref of 1.24V. The voltage converter decreases Vswitch in order to achieve the required decrease in current I**1**. As Vswitch decreases, so too does the voltage applied to the motor **134**.

As discussed above, the drive system **402** optionally includes a controller **404** that receives a dispensing parameter **420** from the motive power device **418** to facilitate a desired mode of operation. For example, the controller **404** might receive a motor back EMF to monitor the speed of a motor of the motive power device **418**. In an embodiment that uses voltage and/or a change in voltage to effectuate a desired output drive condition to the dispensing apparatus **416** via the motive power device **418**, the desired mode of power control may be a PWM technique. As discussed above, an embodiment employs a microprocessor equipped controller **404** disposed and configured in operable communication with the drive system **402** to facilitate the drive system **402** to operate in a first output drive condition in response to one of the aforementioned dispensing parameters having the first value, and to facilitate the drive system **402** to operate in a second output drive condition in response to the dispensing parameter having the second value.

Mechanical Control

In exemplary embodiments, as illustrated in FIG. **5**, the dispenser **500** may utilize one or more mechanical schemes to implement the first output drive condition or the second output drive condition. In exemplary embodiments, the secondary motive power device **512** may include a transmission having a two-stage drive arrangement. The output of the transmission of the secondary motive power device **512** is connected to the dispensing apparatus **516** and provides an output characterized by the dispensing parameter **520** to the dispensing apparatus **516**. The two-stage drive arrangement includes a high drive that is engaged during the first output drive condition and a low drive that is engaged during the second output drive condition. The low drive includes a drive ratio that results in a reduced output speed but an increased output torque, as compared to the high drive. As used herein, the term "drive" means gear, belt, pulley, lever, or any other mechanical drive system capable of providing input/output drive ratios, and any reference to a "gear" or "geared" system is intended to incorporate all such drive systems suitable for a purpose disclosed herein. In exemplary embodiments, a multi-stage geared arrangement may be employed in place of the two-stage geared arrangement, resulting in variable output torque drive.

In exemplary embodiments, the transmission may be a two-speed self-actuating transmission for achieving higher torque output from a relatively small motor. As discussed above, the transmission may be part of the secondary motive power device **512** and can be in high gear, or high drive, during normal operation against normal dispensing resistance when low torque is required, such as when dispensing a single thickness of sheet product from the body of the stub roll. If the dispensing parameter **520** increases above a threshold torque, such as if breaking the adhesive at the end of the stub roll **508** increases dispensing resistance **510** above a threshold torque, then the transmission can automatically shift to low gear, or low drive.

In exemplary embodiments, the transmission can include a planetary gear-set with a 1:1 gear ratio in high gear, and a 5:1 gear ratio in low gear. While certain gear ratios are depicted herein, it will be appreciated that this is for discussion purposes only, and that other gear ratios suitable for the purpose disclosed herein are also considered within the scope of the invention.

Referring now to FIG. **15**, an exemplary two-speed self actuating transmission **600** is shown. The transmission **600** includes a sun gear **602** that receives input from a motor (which is the primary motive power device in this embodiment), planet gears **604**, **606** that are coupled to the sun gear **602** via a planet carriage **608** and a drive roller bar **610**, and a ring gear **612**. The drive roller bar **610** includes a drive roller shaft **614** that is coupled to the dispensing apparatus **516**. The planet carriage **608** is coupled to the drive roller bar **610** via a tension spring **616** disposed at one end of the drive roller bar **610**. The tension spring **616** acts to bias the locking mechanism **618** disposed at both ends of the drive roller bar **610** in engagement with the planet gears **604**, **606**.

During normal operation, that is when in high gear, the motor causes a clockwise rotation of the sun gear **602** and the sheet product being dispensed exerts minimal torque, feedback torque, on the drive roller shaft **614**. As used herein, the term minimal torque refers to a drive condition where a first value of torque that is less than a threshold torque (indicative of low dispensing resistance **510**). In exemplary embodiments, the minimal torque is not sufficient to overcome the tension spring **616**, so the projection of the locking mechanism **618** engages with the teeth of the planet gears **604**, **606** to prevent the planet gears **604**, **606** from rotating relative to the planet carriage **608**, which forces the entire transmission **600**, including ring gear **612**, to rotate with the sun gear **602** and motor.

During a high torque load condition on the drive roller shaft **614**, such as when the adhesive at the end of the stub roll is being broken, for example, the tension spring **616** extends and releases the locking mechanism **618** from the planet gears **604**, **606** allowing the planet gears **604**, **606** to rotate independent of planet carriage **608**. As a result, the torque from the motor and the torque from the drive roller combine to attempt rotation of the ring gear **612** counter-clockwise. However, a one-way mechanism **620**, such as a ratchet, or a sprig clutch for example, engages with the ring gear **612** to prevent the ring gear **612** from rotating counter-clockwise. As a result, the only remaining degree of freedom is for the sun gear **602** to rotate the planet gears **604**, **606** via the planet carriage **608**, causing the planet carriage **608** to rotate clockwise with a slower speed and a higher torque than the motor. The tension spring **616**, and an optional hard stop **622** between the drive roller bar **610** and the planet carriage **608**, cause the planet carriage **608** to rotate the drive roller bar **610** and drive roller shaft **614** clockwise. This high torque load condition is herein referred to as a second value of torque greater than the threshold torque (indicative of elevated dispensing resistance **510**). As herein discussed, the second torque is greater than the first torque and is sufficient to overcome the elevated dispensing resistance **510**.

As the torque load on the drive roller shaft **614** decreases, such as upon breakage of the aforementioned adhesive, the tension spring **616** becomes sufficient to lock the locking mechanism **618** of the drive roller bar **610** with the planet gears **604**, **606**, and to lock the planet gears **604**, **606** with the planet carriage **608**, thereby forcing the entire transmission **600** to resume rotation with a 1:1 gear ratio.

In an alternative embodiment, the drive roller shaft **614** is optionally equipped with a torsion spring (not specifically shown, but appropriately and understandably coupled between the drive roller shaft **614** and the planet carriage **608**) that absorbs and smoothes out the torque required to start rolling the towel at the beginning of a dispense operation. By smoothing out the start-up torque, it is contemplated that the transmission **600** will not temporarily shift into low gear at the beginning of each dispense cycle.

From the foregoing discussion of a two-speed transmission, it will be appreciated that a multi-stage geared arrangement may be employed in place of the two-stage geared arrangement, which is considered to be within the scope of the invention disclosed herein.

In a further exemplary embodiment, the secondary motive power device **512** may include a mechanical impulse force generator to generate an impulse force having a peak force greater than that of a steady state force. The mechanical impulse force generator can be used to generate an impulse force that is capable of overcoming an elevated dispensing resistance.

Referring now to FIG. **16**, a mechanical impact device **700** in accordance with an exemplary embodiment is shown. The mechanical impact device **700** may be configured as part of secondary motive power device **512** and be coupled to a dispensing apparatus **516**, via an outer housing **712**. The mechanical impact device **700** may also be operably coupled to a motor (which is the primary motive power device in this embodiment) via an input shaft **710**. In an embodiment, the impact device **700** includes a hammer portion **702** and an anvil portion **704** having a slip surface **706** to form a slip mechanism, alternatively referred to as a bypass mechanism, which may be collectively referred to by reference numerals **702**, **704**, **706** and **708** in combination. The hammer portion **702** is operably connected to the anvil portion **704** via the slip surface **706** and a spring **708**, which is suitably disposed to bias the hammer portion **702** toward the anvil portion **704**. In an embodiment, the spring **708** is a compression spring, but any spring suitable for the purpose disclosed herein is considered within the scope of the invention. Such a contemplated suitable spring is a torsion spring coupled between the hammer portion **702** and the input shaft **710**. A first end of the hammer portion **702** is pivotally coupled in an off-axis manner, which is eccentrically, to the input shaft **710**, while the second opposing end of the hammer portion **702** is slidably coupled to the anvil portion **704** via the slip surface **706**, as discussed above. As the motor rotates clockwise, the input shaft **710** rotates clockwise, causing the pivotally connected first end of the hammer portion **702** to rotate clockwise about the pivot axis of the input shaft **710**, which in turn causes the hammer portion **702** to push against the anvil portion **704**.

Under normal operating conditions, also herein referred to as operating below a slip threshold, the spring **708** is of sufficient strength to maintain engagement of the hammer portion **702** with the anvil portion **704** as the input shaft **710** rotates clockwise, thereby resulting in the bypass mechanism operating in a non-bypass mode. That is, no slippage between the hammer portion **702** and the anvil portion **704** at the slip surface **706**, resulting in the input shaft **710**, the hammer portion **702**, the anvil portion **704**, and the outer housing **712** all rotating together. As such, the dispensing apparatus **516** is operably connected to receive non-impact output force from the impact device **700** via a non-bypass mode of operation in response to the drive system **502** dispensing against a low dispensing resistance **510**.

During a high torque load condition on the input shaft **710**, also herein referred to as operating above a slip threshold, the outer housing **712** is resisted in rotation relative to the input shaft **710** due to drag or increased dispensing resistance **510**, causing the compression spring **708** to compress and the hammer portion **702** to slip by the slip surface **706** of the anvil portion **704**, thereby resulting in the bypass mechanism operating in bypass mode. After the hammer portion **702** slips by the slip surface **706**, the input shaft **710** and hammer portion **702** rotate while the outer housing **712** remains stationary, or at least rotates at a slower rate. As the input shaft **710** and the hammer portion **702** rotate, they gain or maintain momentum. After one revolution of the input shaft **710**, the hammer portion **702** strikes the slip surface **706** of the anvil portion **704**, which in turn transmits an impulse of energy or output force to the outer housing **712**, which transmits an impulse of torque to the dispensing apparatus **516**. As such, the dispensing apparatus **516** is operably connected to receive an impact output force greater than the force from the impact device **700** via a bypass mode of operation.

Referring now to FIGS. **17**A and **17**B, a mechanical impact device **750** in accordance with another exemplary embodiment is shown. The mechanical impact device **750** may be configured as part of the secondary motive power device **512** and be coupled to a dispensing apparatus **516**, via a gear **762**. The mechanical impact device **750** may also be operably coupled to a motor **134** via an input shaft **760**. In an embodiment, the impact device **750** includes an impact sleeve **752** having an anvil portion **766** and the gear **762** includes an impact surface **756**.

In exemplary embodiments, during normal operating conditions the motor **134** rotates the retainer sleeve **754**, the spring **758**, and the pin **764**. The spring **758** pushes the anvil portion **766** of impact sleeve **752** against the impact surface **756** of the gear **762**, which rotates the dispensing apparatus **516**. If dispensing resistance against the gear **762** is low, the gear **762** is engaged with and rotates with the impact sleeve **752** and motor **134**. If dispensing resistance against the gear **762** is high, the gear **762** and impact sleeve **752** will stop rotating, but the retainer sleeve **754** and pin **764** will continue to rotate with the motor **134**, during which time the rotation of the pin **764** causes the impact sleeve **752** to raise against the spring **758** and slip over impact surface **756** of the gear **762**. Once this happens, the impact sleeve **752** rotates with the motor **134** for a full revolution until the anvil portion **766** impacts the impact surface **756** of the gear **762**, imparting a burst of energy intended to overcome peak dispensing resistance.

While specific structures of impact devices **700**, **750** have been discussed, it will be appreciated that the scope of the invention is not limited to only the structures disclosed, but also encompasses any impulse mechanism disposed in the drive system **502**, where such a mechanism may be embodied as impact wrenches used in automotive repair shops for example. A contemplated suitable impulse mechanism first accumulates rotational energy and then quickly releases that energy in the form of an impulse, which is contemplated to be effective at bumping the drive roller to overcome high torque loads on the drive roller.

In exemplary embodiments, the primary motive power device **518** may include a first motor and the secondary motive power device **512** may include a second motor that is configured to provide additional torque when combined with the first motor. The dispenser **500** can be configured to use torque from only the first motor during the first output drive condition, and to use torque from only the second motor or a combination of the first and second motors during the second output drive condition.

Referring now made to FIG. **18**, an exemplary dual motor drive system **800** is shown. The dual motor system **800** includes a first motor **802** and a second motor **804**. In one embodiment, the first motor **802** is connected to gear-1 **808**, which rotates a dispensing apparatus **516** attached to gear-3 **810**. Gear-3 **810** is also connected to gear-2 **812**, which contains a one-way clutch **806**. In an embodiment, the one-way clutch **806** is configured to determine whether a threshold torque or threshold speed has been crossed. Under a dispensing condition, the first motor **802** rotates gear-1 **808** counterclockwise, which rotates gear-3 **810** clockwise, which rotates gear-2 **812** counterclockwise. When gear-2 **812** rotates faster than the second motor **804**, which also rotates counterclockwise, the one-way clutch **806** freewheels and gear-2 **812** is disengaged from the second motor **804**. As an increase in dispensing resistance **510** causes torque against the first motor **802** to increase (or the speed of the gears to decrease), the torque or speed eventually will cross the threshold level, beyond which the second motor **804** rotates at the same speed as gear-2 **812**. When this happens, the one-way clutch **806** engages, allowing the second motor **804** to contribute torque to gear-2 **812**, gear-3 **810**, and the dispensing apparatus **516** attached to gear-3 **810**. In one embodiment, the second motor **804** is energized when the first motor **802** is energized. In another embodiment, the second motor **804** is de-energized when the first motor **802** is energized, and then the second motor **804** is energized when the torque or speed threshold is crossed. In yet another embodiment, the first motor **802** is de-energized when the second motor **804** is energized.

In view of the foregoing, it will be appreciated that the first motor **802** and the second motor **804** may have similar or different torque output capabilities, depending on whether the first motor **802** and the second motor **804** are energized at the same time or not. For example, if the first motor **802** is de-energized when the second motor **804** is energized, then the second motor **804** would need to have a greater torque output capability than the first motor **802**. In another example, if the first motor **802** is energized when the second motor **804** is energized, then the second motor **804** could have equal, greater, or less torque output capability as compared to the first motor **802**. If the first motor **802** and the second motor **804** are both energized, the second motor **804** could have equal or less torque output capability as compared to the first motor **802** since the effective output torque is cumulative.

In an embodiment where the first motor **802** and the second motor **804** are always energized together, gear-1 **808** and the first motor **802** might rotate at 600 rpm against 1 in-lb torque resistance during a typical dispensing operation. This would cause gear-3 **810** to rotate at 150 rpm against 4 in-lb torque resistance, and gear-2 **812** to rotate at 600 rpm against 0 in-lb torque resistance. An elevated torque resistance from the dispensing apparatus **516** might increase enough to slow the first motor **802** to 6 rpm. At this point, the one-way clutch **806** in gear-2 **812** would engage. As a result, the first motor **802** and gear-1 **808** would contribute 5 in-lb of torque to gear-3 **810**, and the second motor **804** and gear-2 **812** would be on the verge of contributing torque to gear-3 **810**. If the dispensing resistance **510** from the dispensing apparatus **616** increased further, the first motor **802** and the second motor **804** might slow down to 4 rpm. As a result, the first motor **802** and gear-1 **808** would contribute 6 in-lb of torque to gear-3 **810**. Since the second motor **804** is still engaged with gear-2 **812**, gear-2 **812** would contribute 10 in-lb of torque to gear-3 **810**. Therefore, the first motor **802** and the second motor **804** would apply a total of 16 in-lb of torque to gear-3 **810**, which would allow gear-3 **810** to overcome a torque resistance of 64 in-lb from the dispensing apparatus **516**. Once the dispensing resistance **510** begins to decrease, speed of the first motor **802** and gear-1 **808** will increase to 6 rpm as above, at which point the one-way clutch **806** will disengage and the second motor **804** will not provide output drive torque to gear-3 **810** via gear-2 **812**.

In view of the foregoing, it will be appreciated that an embodiment includes an arrangement where the primary motive power device **518** includes a first motor **802** and the secondary motive power device **512** includes a second motor **804** that are operably coupled with the dispensing apparatus **516**. The dispensing apparatus **516** is operably connected to receive output from the first motor **802** in response to the drive system **502** being operated in a first output drive condition, and is operably connected to receive output from a combination of the first motor **802** and the second motor **804** in response to the drive system **502** being operated in the second output drive condition. In an embodiment, the dispensing apparatus **516** includes a drive roller and a pinch roller, where the drive roller is operably connected to receive output from the first motor **802** in response to the drive system **502** being operated in the first output drive condition, and is operably connected to receive output from a combination of the first motor **802** and the second motor **804** in response to the drive system **502** being operated in the second output drive condition.

In view of the embodiment mentioned above where the first motor **802** may be de-energized when the second motor **804** is energized, it will be appreciated that an embodiment also includes an arrangement where the second motor **804** is the only motor output for conditions where the torque or speed exceeds the threshold values. It will be appreciated that both mechanical and electrical control schemes can be utilized for selectively energizing and de-energizing the first and second motors under certain operating conditions.

Referring now to FIGS. **5** and **19**, an analog circuit **900** is depicted for controlling an embodiment where a primary motive power device **518** includes a motor **902** and a secondary motive power device **512** includes a motor **904**. The analog circuit **900** includes a shunt resistor **908** and a FET transistor **910** that respond to a current I1 through the first motor **902**. When the current I1 through the first motor **902** is low, the shunt resistor voltage $Vr\text{-}V_0$ is lower than the gate voltage required to enable the FET transistor **910**. As a result, the second motor **904** is inactive. When the current through the first motor **902** is high, $Vr\text{-}V_0$ exceeds the gate voltage required to enable the FET transistor **910**, causing the current I3 to be greater than zero, thereby enabling the FET transistor **910** to collect current I2 and energize the second motor **904**.

When controller **504** of dispenser **500** determines that it should be dispensing material (block **304** of FIG. **3**), the controller **504** closes the dispenser motor switch **906**. The current I1 through the first motor **902** correlates with the torque that the first motor **902** creates to overcome a dispensing resistance **510**. For a low or normal dispensing resistance, I1 is below the current/torque threshold necessary to enable the FET transistor **910**, and the drive system **502** provides a first output condition from the primary motive power device **518** to the dispensing apparatus **516**. For a higher dispensing resistance, I1 exceeds the current/torque threshold necessary to cause I3 to exceed zero, thereby enabling the FET transistor **910** and the second motor **904** to energize and contribute output, at which time the drive system **502** provides a second output condition from both the primary motive power device **518** and the secondary motive power device **512** to the dispensing apparatus **516**.

In an embodiment, the controller **158** includes a processor **162** coupled to a random access memory (RAM) device **164**, a non-volatile memory (NVM) device **166**, and a read-only memory (ROM) device **168**. The main controller **158** may optionally be connected to one or more input/output (I/O) controllers or data interface devices (not shown). The NVM device **166** is any form of non-volatile memory such as an EPROM (Erasable Programmable Read Only Memory) chip, a flash memory chip, a disk drive, or the like. Stored in the NVM device **166** are various operational parameters for the application code stored in the ROM device **168**. It should be recognized that the application code could be stored in the NVM device **166** rather than in the ROM device **168**.

The main controller **158** includes operation control methods embodied in application code. These methods are embodied in computer instructions written to be executed by the processor **162**, typically in the form of software. The software can be encoded in any language, including, but not limited to, machine language, assembly language, VHDL (Verilog Hardware Description Language), VHSIC HDL (Very High Speed IC Hardware Description Language), Fortran (formula translation), C, C++, Visual C++, Java, ALGOL (algorithmic language), BASIC (beginners all-purpose symbolic instruction code), visual BASIC, ActiveX, HTML (HyperText Markup Language), and any combination or derivative of at least one of the foregoing. Additionally, an operator can use an existing software application such as a spreadsheet or database and correlate various cells with the variables enumerated in the algorithms. Furthermore, the software can be independent of other software or dependent upon other software, such as in the form of integrated software.

As discussed, an embodiment of the invention may be embodied in the form of computer-implemented processes and apparatuses for practicing those processes. The present invention may also be embodied in the form of a computer program product having computer program code containing instructions embodied in tangible media, such as floppy diskettes, CD-ROMs, hard drives, USB (universal serial bus) drives, or any other computer readable storage medium, such as random access memory (RAM), read only memory (ROM), erasable programmable read only memory (EPROM), electrically erasable programmable read only memory (EEPROM), or flash memory, for example, wherein, when the computer program code is loaded into and executed by a computer, the computer becomes an apparatus for practicing the invention. The present invention may also be embodied in the form of computer program code, for example, whether stored in a storage medium, loaded into and/or executed by a computer, or transmitted over some transmission medium, such as over electrical wiring or cabling, through fiber optics, or via electromagnetic radiation, wherein when the computer program code is loaded into and executed by a computer, the computer becomes an apparatus for practicing the invention. When implemented on a general-purpose microprocessor, the computer program code segments configure the microprocessor to create specific logic circuits. A technical effect of the executable instructions is to adjust the output drive of a drive system for a product dispenser from a first output drive condition to a second output drive condition in response to an elevated dispensing resistance in order to overcome the elevated dispensing resistance for continued dispensing of product.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best or only mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited. Moreover, the use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

What is claimed is:

1. A dispenser, comprising:

a product housing configured to receive a product to be dispensed;

a drive system comprising a motive power device and a controller, the drive system configured to receive energy from an electrical energy supply;

a dispensing apparatus disposed in operable communication with the drive system, the dispensing apparatus configured and disposed in operable communication with the product housing to dispense the product;

wherein during a condition when the product is being dispensed the dispensing apparatus is subject to a dispensing resistance and the drive system provides an output to the dispensing apparatus to overcome the dispensing resistance, said output being characterized by a dispensing parameter,

wherein the controller determines the dispensing resistance based on the dispensing parameter and responsively operates the motive power device, such that the controller operates the motive power device in a first output drive condition in response to the dispensing resistance being below a threshold value, and operates the motive power device in a second output drive condition in response to the dispensing resistance being above a threshold value.

2. The dispenser of claim **1**, wherein the second output drive condition, relative to the first output drive condition, includes a greater output from the drive system.

3. The dispenser of claim **1**, wherein during the first output drive condition the controller provides the motive power device a first input voltage and during the second output drive condition the controller provides the motive power device a second input voltage, wherein the second input voltage is greater than the first input voltage.

4. The dispenser of claim **1**, wherein the first output drive condition has a uniform output and the second output drive condition has a non-uniform output.

5. The dispenser of claim **4**, wherein the non-uniform output is an impulse torque.

6. The dispenser of claim **1**, wherein the controller disposed in operable communication between the electrical energy supply and the motive power device is configured to receive the dispensing parameter, and in response to the dispensing parameter modify a voltage from the electrical energy supply and deliver the modified voltage to the motive power device.

7. The dispenser of claim **1**, wherein the dispensing parameter is a dispensing torque required to dispense the product.

8. The dispenser of claim **7**, wherein the motive power device comprises a motor, and wherein the dispensing torque is a function of a current through the motor.

9. The dispenser of claim **1**, wherein the dispensing parameter is a dispensing speed at which the product is dispensed.

10. The dispenser of claim **9**, wherein the motive power device comprises a motor, and wherein the speed is determined by measuring a back EMF of the motor.

11. A dispenser, comprising:

a product housing configured to receive a product to be dispensed;

a drive system comprising a primary motive power device and a secondary motive power device, the drive system configured to receive energy from an electrical energy supply;

a dispensing apparatus disposed in operable communication with the drive system, the dispensing apparatus configured and disposed in operable communication with the product housing to dispense the product;

wherein during a condition when the product is being dispensed the dispensing apparatus is subject to a dispensing resistance and the drive system provides an output to the dispensing apparatus to overcome the dispensing resistance, said output being characterized by a dispensing parameter,

wherein the secondary motive power device is operably responsive to the dispensing parameter, such that the secondary motive power device operates in a first output drive condition in response to the dispensing resistance being below a threshold value, and operates in a second output drive condition in response to the dispensing resistance being above a threshold value.

12. The dispenser of claim **11**, wherein the second output drive condition, relative to the first output drive condition, includes a greater output from the drive system.

13. The dispenser of claim **11**, wherein the first output drive condition has a uniform output and the second output drive condition has a non-uniform output.

14. The dispenser of claim **13**, wherein the non-uniform output is an impulse torque.

15. The dispenser of claim **11**, wherein the primary motive power device comprises a motor, the secondary motive power device comprises a transmission coupled to the motor and the dispensing apparatus comprises a drive roller operably connected to the transmission.

16. The dispenser of claim **15**, wherein the transmission comprises a first drive ratio and a second drive ratio, the dispensing apparatus being operably connected to receive output from the first drive ratio in response to the secondary motive power device being operated in the first output drive condition, and being operably connected to receive output from the second drive ratio in response to the secondary motive power device being operated in the second output drive condition.

17. The dispenser of claim **11**, wherein the primary motive power device comprises a first motor and the secondary motive power device comprises a second motor, the dispensing apparatus being operably connected to receive output from the first motor in response to the secondary motive power device being operated in the first output drive condition, and being operably connected to receive output from a combination of the first motor and the second motor in response to the secondary motive power device being operated in the second output drive condition.

18. The dispenser of claim **11**, wherein the primary motive power device comprises a first motor and the secondary motive power device comprises a second motor, the dispensing apparatus being operably connected to receive output from the first motor in response to the secondary motive power device being operated in the first output drive condition, and being operably connected to receive output from the second motor in response to the secondary motive power device being operated in the second output drive condition.

19. The dispenser of claim **11**, wherein the primary motive power device comprises a motor and the secondary motive power device comprises an impact device, the impact device operably connected between the motor and the dispensing apparatus.

20. The dispenser of claim **19**, wherein the impact device comprises a hammer portion and an anvil portion, the hammer portion being operably connected to the anvil portion via a bypass mechanism, the bypass mechanism being operable in a non-bypass mode and in a bypass mode, the dispensing apparatus being operably connected to receive output from the impact device in the non-bypass mode in response to the secondary motive power device being operated in the first output drive condition, and being operably connected to receive output from the impact device in the bypass mode in response to the secondary motive power device being operated in the second output drive condition.

21. A dispenser, comprising:

a product housing configured to receive a product to be dispensed;

a drive system comprising a primary motive power device, a secondary motive power device and a controller, the drive system configured to receive energy from an electrical energy supply;

a dispensing apparatus disposed in operable communication with the drive system, the dispensing apparatus configured and disposed in operable communication with the product housing to dispense the product;

wherein during a condition when the product is being dispensed the dispensing apparatus is subject to a dispensing resistance and the drive system provides an output to the dispensing apparatus to overcome the dispensing resistance, said output being characterized by a dispensing parameter,

wherein the controller determines the dispensing resistance based on the dispensing parameter and responsively operates the secondary motive power device, such that the controller operates the secondary motive power device in a first output drive condition in response to the dispensing resistance being below a threshold value, and operates the secondary motive power device in a second output drive condition in response to the dispensing resistance being above a threshold value.

22. The dispenser of claim **21**, wherein the second output drive condition, relative to the first output drive condition, includes a greater output from the drive system.

23. The dispenser of claim **21**, wherein the first output drive condition has a uniform output and the second output drive condition has a non-uniform output.

24. The dispenser of claim **23**, wherein the non-uniform output is an impulse torque.

25. The dispenser of claim **21**, wherein the primary motive power device comprises a first motor and the secondary motive power device comprises a second motor, the dispensing apparatus being operably connected to receive output from the first motor in response to the secondary motive power device being operated in the first output drive condition, and being operably connected to receive output from a combination of the first motor and the second motor in response to the secondary motive power device being operated in the second output drive condition.

26. The dispenser of claim **21**, wherein the primary motive power device comprises a first motor and the secondary motive power device comprises a second motor, the dispensing apparatus being operably connected to receive output from the first motor in response to the secondary motive power device being operated in the first output drive condition, and being operably connected to receive output from the second motor in response to the secondary motive power device being operated in the second output drive condition.

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